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MINING AND INDUSTRIAL PROGRESS IN SWEDEN.

By John Geo. Leigh.

The recent engineering and manufacturing development of Sweden has been rapid; with the opening of the railway through the rich ore fields north of the Arctic circle and the extension of hydro-electric installations, are now allied many important ship-canal and other projects and a general quickening of industrial activities. The possibilities are most interesting for all who are engaged in engineering, contracting, or machinery building. In the present article Mr. Leigh surveys the most significant undertakings or proposals now receiving consideration. In another to follow in a later issue he will take up the methods and characteristics of representative establishments. He writes at first hand, with the vigor and authority of a trained observer, and the broad viewpoint of one long familiar with the spirit and policy of some of the world's greatest pioneers in the exploitation of the resources of a rising industrial nation.—THE EDITORS.

IN no country is there larger excuse than in England for the reflection that much of the energy and capital devoted, not unfrequently with prodigal recklessness, to the opening-up of unknown or semi-civilised lands, or to the furtherance of great distances of magnificent and altruistic ideas, might often be employed to far greater advantage, to all concerned, at home or close at hand. Even in these comparatively prosaic days, when, as we are wont to believe, every project is weighed with cold calculation before its benediction by capital, imagination and the glamour of distance play by no means insignificant *rôles*. In the lives of the most matter-of-fact of business men, there are moments when the pulse is quickened by a craving for adventure, the ordinary routine is illumined by a flash of sentiment, poetry takes the place of sober prose. It is well for many reasons that this is so, for such lapses beget not merely wondrous pity for the aboriginal, self-satisfied without the resources of latter-day civilisation, not merely dreams of untold wealth, but engineering and other enterprises of more than ordinarily important character, which, under other conditions, might never be practically tested.

Yet in these things lurks a danger more serious than individual ruin, disillusion, and disappointment, with their inevitable consequence —exaggerated caution in the future. They tend, only too frequently, to divert attention from necessities and movements nearer home, less sensational perhaps, but offering as great and beneficent opportunity for safe and welcome co-operation. Thoughts such as these could not fail to obtrude themselves during a recent tour through Sweden, and, since then, when summing-up the lessons derived from it and the conclusions based upon observations. Already in the last decade signs were not wanting that this Scandinavian kingdom might readily emerge from the state of comparative isolation into which, since the aftermath of her once conspicuous position among the European nations, she had been thrust by political circumstances. The visit of the Iron and Steel Institute in 1898 revealed aspirations which had hitherto found scant or no expression, and not a few sympathetic and clear-sighted foreigners recognised that the day was approaching when Sweden would be esteemed not only as a store-house of timber and iron ore and because of the intellectual and inventive capacity of her sons, but also as the home of a people striving to take fitting place in the modern system of industrial life.

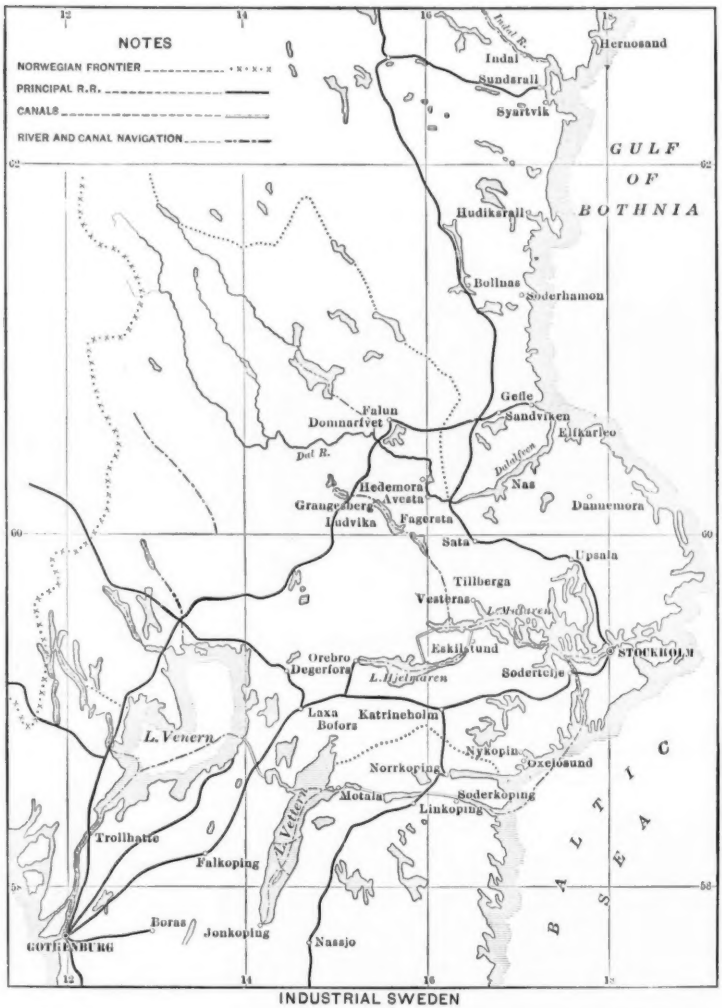
Many readers may remember that, following the meeting of the Iron and Steel Institute to which reference has been made, there appeared in THE ENGINEERING MAGAZINE two articles by Dr. David A. Louis.* The first described at length the iron-mining and iron- and steel-making industries of Central Sweden, while the second included mention of the railway between Gellivare and the Norwegian frontier and seaboard, projected with a view to opening to the world the rich ore deposits of that remarkable range of heights then known by little more than name as Kirunavara and Luossavara. Since these articles were published, much has happened in Sweden, as elsewhere. In the central provinces, aided by the best appliances and the adoption of the most up-to-date methods of modern practice, there has been an ever-increasing output of raw material and manufactured products, and new industries have been created with conspicuous success. The Gellivare-Narvik railway has been opened and is operating smoothly, thriving settlements have arisen in the neighbourhood of the "iron mountains," and ores from Arctic Norrland are available for export in larger quantities than are actually permitted. It will be the purpose of the present and following contributions to outline the economic conditions responsible for existing

* The Iron Industry of Sweden, June, 1899; The Great Magnetite Deposits of Swedish Lapland, July, 1899.

developments, to indicate the probable issues of the latter, and to suggest means whereby they may be advantageously assisted from without. Therefore, although necessarily less technical in character and scope than were those of Dr. Louis, the articles may be regarded as a natural sequel to their predecessors of nine years ago.

The ordinary laws of progress fail to supply adequate explanation of the phenomena that during the past few years the national wealth of Sweden, the assessed value of real property, the income derived from capital and labour, and the volume of international commerce all show ratios of increase largely in excess of previous periods, and —having regard for varying conditions—comparable with or superior to equivalent statistics of the most thriving of nations. The real explanation must be looked for in the fact—of which I hope in the following pages to offer convincing proof—that this so-called "poor" country of Sweden has of late years been the scene of a general economic expansion, which, if continued (and of this there appears every likelihood) should soon cause people to abandon the qualification as out of date, if, indeed, it ever was warranted. A new spirit of enterprise, based largely upon recognition of the riches which still lie fettered in the hearts of the mountains or run to waste in its abundant waterfalls, has taken hold of the nation. The ultimate goal, of course, is to transform the raw-product industries into manufacturing ones, and so bring about the invasion of modern industrialism into practically every department of the occupations of the people. Outward evidences of this are seen in the increased attention devoted to commercial and technical training, in the tendency of recent legislation, in the amalgamation of competing interests under a harmonious and common direction, and in the increasing number of company formations.

Though Sweden has been comparatively well-to-do during the preliminary years of the present period of transition, its capital cannot be regarded as in any degree adequate to meet existing, much less coming, requirements. To carry out even a few of the more ambitious enterprises projected with a view to utilising the natural resources of the country, the latter needs to increase from without its working capital. This the Swedes themselves are not reluctant to admit, though heretofore the idea of borrowing has been somewhat foreign to the national instinct, as evidenced by the facts (1), that the small public debt of £21,000,000—contracted almost exclusively for the purpose of railway construction and loans—mainly represents home investments; and (2), that the total external liabilities of the country do not greatly exceed £33,000,000.

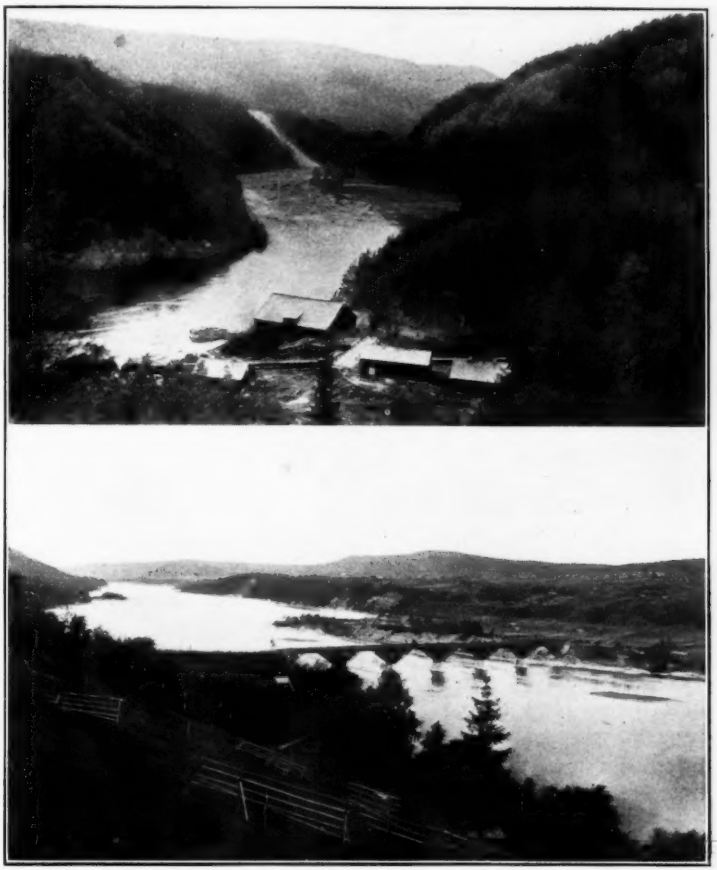


INDUSTRIAL SWEDEN

Sweden covers 4.57 per cent. of the area of Europe, and is, consequently, one of the larger countries of that continent. It is rather smaller than France or Germany, but nearly half as large again as Great Britain and Ireland. As an economic and industrial unit, it is convenient to consider it as made up of three main sections, viz.,

Central Sweden, or Svealand—the limits of which are indicated in the accompanying map by dotted lines and a portion of the Göta Canal; Southern Sweden, or Götaland; and Norrland, extending to the Arctic Ocean.

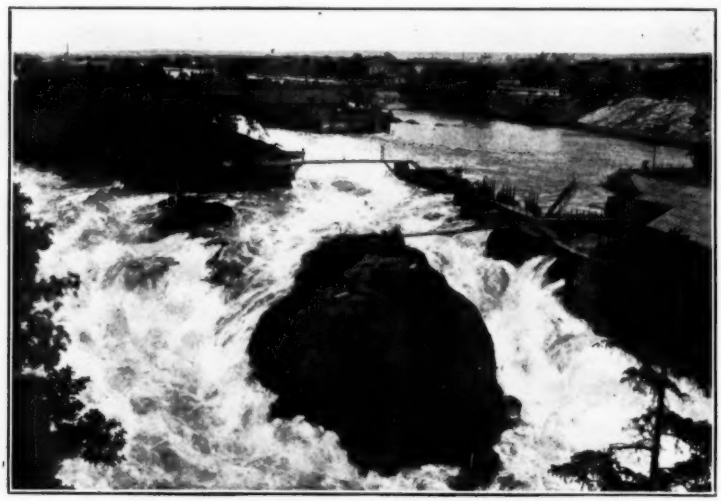
The extreme south, the peninsula of Scania, is extremely fertile, and its people, as a result, have always devoted themselves particularly to the profession of agriculture. Even here, however, thanks to the favourable geographical position of the province and the wealth



VIEWS ON THE INDAL RIVER, NORRLAND.

The upper one shows the Sillve Rapids and old sawmill.

of its inhabitants, marked changes have taken place during recent years, with the result that Scania to-day rivals other parts of the country in variety of industrial interests. Immediately to the north is the well-wooded and watered, but otherwise naturally poor, province of Smäland, beyond which, on either side of the old volcanic lake, Vettern, are the ancient seats of agriculture, Ostergöthland and Vestergöthland, the fertile plains of which are broken here and there by metalliferous hills, for the most part neglected of the prospector.



TROLLHATTE FALLS; THE SITE OF A PROPOSED HYDRO-ELECTRIC STATION.

Over a large portion of Svealand, on the other hand, the mining of ores, and particularly of iron, has long been a formidable rival to the claims of agriculture, and now, on all sides, in its various provinces, there are arising allied manufacturing industries, of great interest to Sweden, and not to be lightly esteemed by other nations. As an outlet for the products of this activity Nature has provided the wide-stretching, many-bayed Lake Malaren, near whose junction with the Baltic lies Stockholm, the nation's beautiful and busy capital; while adjacent to the western ore regions is Lake Venern, with the Gota Elf, its egress to the North Sea.

North of Svealand extends the immense territory, representing two-thirds of the kingdom, to which has been given the name of Norrland. Neglected until quite recent years, because of its ex-

tent, inaccessibility and climate, Norrland bids fair to become, in the near future, one of the best-prized of the nation's assets. Its forests, untouched for generations, are adding year by year to the value of Sweden's exports; the fine iron ores with which its mountains are enriched everywhere command a ready market, and the mighty waterfalls along the courses of its rivers are certain sources of a power calculated to expedite in no small degree the development of local and national industries.

The changes now in progress, and referred to in foregoing paragraphs, are indicated in the movements of population during recent years. Without going into details, it may be stated that Sweden's entry into the sphere of modern industrial concentration and international competition has been accompanied by conditions specially unfavourable to herself. The period of transition was consequently marked by serious economic difficulties, notably expressed by a volume of emigration which often almost neutralised the natural increase of population. Thus it happens that there are in the United States and Canada about 1,350,000 people of Swedish origin and that the Swedish population of Finland and other countries of northern Europe numbers at least 500,000. Since 1894, however, emigration has sunk to a relatively low point, and the growth of population has compared favourably with the whole of Europe.

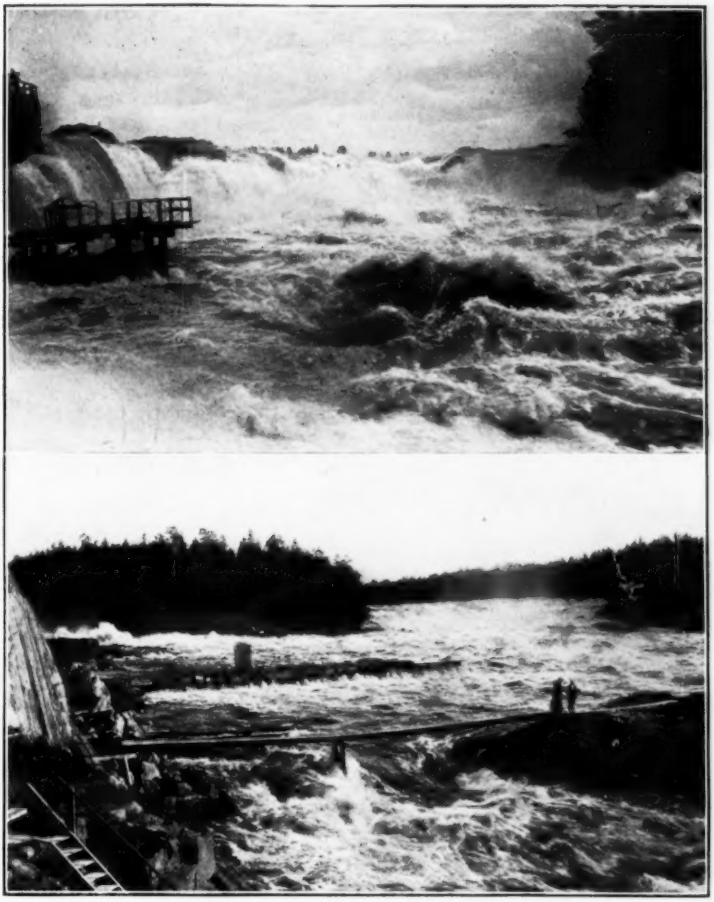
Of late years, consequent upon the birth of new industries and the development of those of older date—and also, in a measure, the special administrative privileges and educational advantages enjoyed by urban communities—the town population has increased much more rapidly than that of the rural districts. Even now, however, over 50 per cent of the population is engaged in agriculture, as against about 30 per cent in industrial occupations, lumbering and mining included, and the town inhabitants represent but 23 per cent of the whole. There are three cities only with populations exceeding 50,000—the capital, which in 1850 had 93,000 inhabitants and has now 380,000; Gothenburg, the population of which has within the same period increased six-fold, to 152,000; and Malmo, the busy commercial port of Scania, which has grown in the same proportion and has now 71,000 inhabitants. The growth of Norrköping and Borås, centres of the textile industry; of Jonköping and Orebro, celebrated for their matches; of Eskilstuna, a youthful and diminutive Birmingham, to which I shall have occasion to refer in my second article; of Sundsvall, Gefle, Söderhamm and Hernösand, centres of the saw-mill industry and ports for the export of timber; of Lulea, the port from which

the Gellivare iron ore is shipped, and of the many nuclei of towns arising about the larger factories, is equally and often even more noteworthy.

Generally speaking, the towns are more extensive than might be expected from the number of inhabitants, are attractive by reason of their cleanliness and order, and retain, in larger degree than is usual in other countries, the better natural conditions of rural life. It is well that it is so and that the newer industrial development is widely diffused and not restricted to a few centres, for in the larger town the rise in value of real estate is truly remarkable. In Stockholm, for instance, the gross rateable value of property (the market price being about 10 per cent higher) was £60,869,000 in 1906, as compared with £40,000,000 in 1899 and £1,500,000 in 1859. As a result, the rent required for what may be described as a lower middle-class or artisan's dwelling is more than double that ruling in the larger cities of England and the United States.

SUNDSVALL HARBOUR.

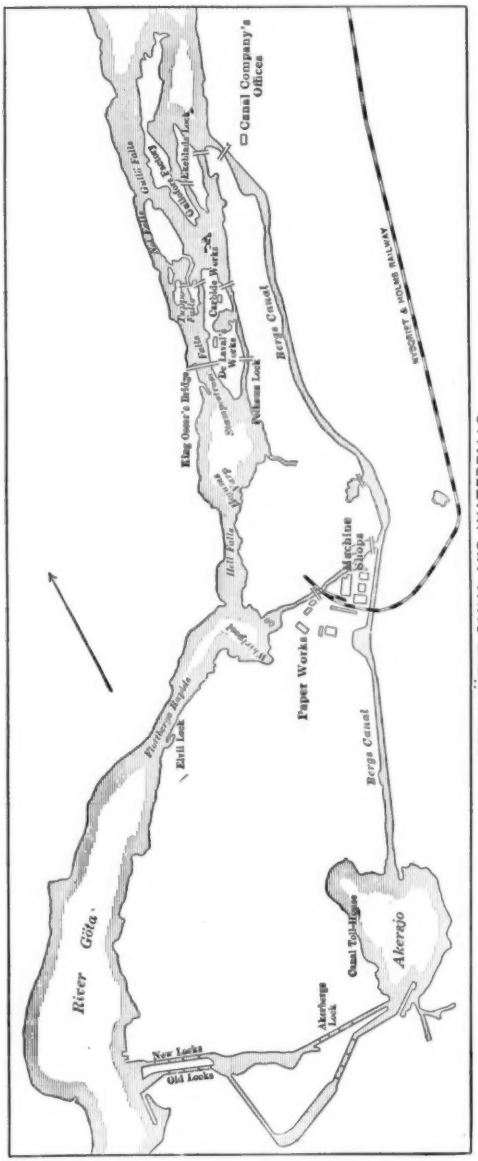
Mention may here be made of four important engineering projects —typical of the enterprises necessary to give full effect to the present industrial movement—which, it is hoped, may shortly take practical form. I refer to the propsed conversion of the Göta and Trollhatte Canals into highways for large-sized vessels and the erection at the Trollhatte Falls and on the river Dalelfven (Elfkarleo Falls) of works for the generation and transmission of electrical power to Gothenburg and Stockholm respectively.



ELFKARLEO FALLS, ON THE RIVER DALELFVEN.

The upper view shows the site of the proposed hydro-electric station.

Of the Swedish canals and water-ways and their influence upon the cultivation and colonisation of the country, a very interesting history might be written. In default, however, of space to this end, it must suffice to mention that attention was directed in Sweden earlier than in most European States to the value of artificial water-ways intended to link and make more serviceable those provided by nature, and that early in the sixteenth century the first king of the



TROLLHÄTTE CANAL AND WATERFALLS.

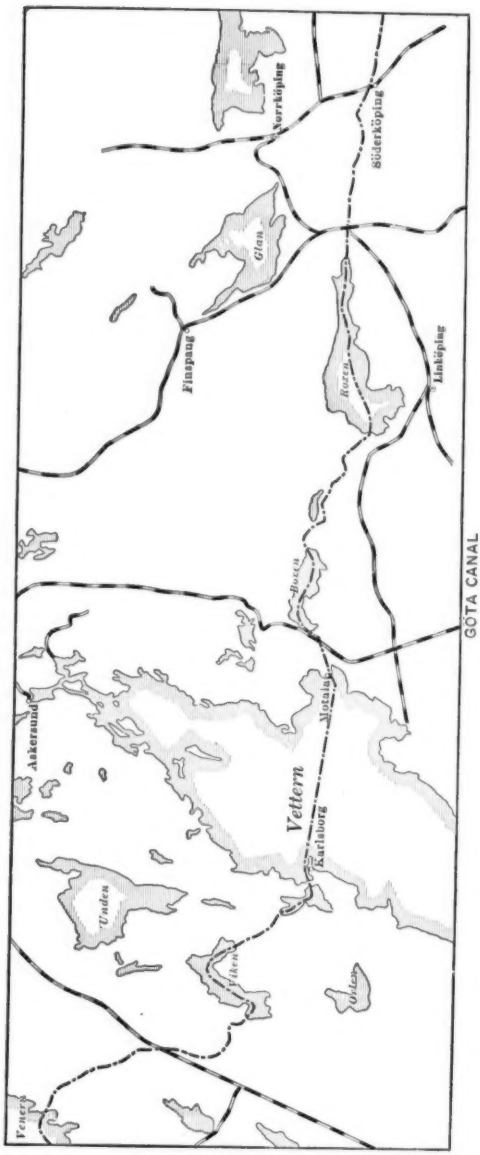
Vasa dynasty projected practically all the great canals now in existence or proposed. Unfortunately, in Sweden, as elsewhere, all canals built in other than quite recent years have failed to confirm the high hopes based upon them. They have been useful for purely local traffic, but, as a general rule, owing to their inferior dimensions and the revolutions effected, first, by the introduction of steam as a motive power and iron as a building material, and, secondly, by the competition of railways, they have proved comparative failures in facilitating commerce and international navigation. In no country is this felt more keenly than in Sweden, the inland ports of which are numerous and in close proximity to the great centres of industry.

Navigation through the existing Trollhatte Canal is restricted to vessels of less than 110 feet length, 28 feet beam, 9 2/3 feet draught and 250 tons displacement. To the enlarged canal, however, which is projected, vessels might be admitted 325 feet long, 47 feet wide, drawing 19 1/2 feet and having a displacement of 5,000 tons. The number of locks would be reduced from sixteen to six and the time of transit lessened from three hours to one. By means of canals from Lake Venern, via Lake Vettern, to the Baltic, and from Lake Venern, via Lake Hjëlmaren, to Lake Mälaren, in conjunction with auxiliary canals of shorter length, all constructed on the above-mentioned scale, there would be secured not only a much-needed traffic transit between the North and Baltic Seas, but also direct water communication between many important inland manufacturing centres and foreign countries, very helpful to international trade. Data concerning existing canals may be thus conveniently summarised:

CANALS AND CANALISED WATER-SYSTEMS.

	Year of construction.	Length, Miles. Total.	Length, Miles. Artificial.	Depth, ft.	Bottom width, ft.	No. of locks.
Trollhatte	1838-44	51	5	9.8	39	16
Göta	1810-32	126	55	9.8	46	58
Sodertelge	1806-19	1.5	.7	12	39	1
Hjälmaren	1819-30	40	5	7	36	9
Orebro	1887-8	1.4	1.4	7	26	1
Eskilstuna (Upper and Lower)	1855-60	6.5	.7	8	26	3
Stromsholm	1842-60	62.5	1	5	32	31
Dalsland	1865-9	160	5	5	15	28
Snacke	1872-4	8.5	.06	7	14	1
Kinda	1865-71	50	16	5	16	15
Seffle	1866-70	56.5	7.5	7	25	1
Stockholm Lock	1845-50	.06	.06	12	32	1
Nine others	.....	140	8	..	..	16

To the United Kingdom and Germany, which share more than 60 per cent of Sweden's external commerce, a ship-canal across Svealand could not fail to be particularly advantageous. Germany now pays toll to Denmark for much of her trade with the northern kingdom, but if goods could be transported across the peninsula at rates low enough to make Gothenburg the chief shipping port, exports might thence be carried direct to Hamburg by open sea. English interests are equally concerned, remembering that British shipping naturally frequents the western coast in preference to the often frozen and dangerous and always intricate Baltic Sea, with its high insurance rates. Touching the prospects of the enterprise, it is significant that even now, despite the limited accommodation, no fewer than 10,000 and 6,000 vessels annually pass through, respectively, the Trollhatte and Göta Canals.



The municipal authorities of Gothenburg have recently given practical proof that they share the cheerful optimism of the country generally and regard with extreme hopefulness the two enterprises at Trollhatte to which I have referred. They believe that much of the anticipated increased traffic through the enlarged canal must directly benefit the terminal city and port, and that such must be the result also of any larger employment of electrical power—that, thanks to both, there will be a marked industrial development along the canal route and on the banks of the Göta, taking its requirements from abroad and exporting its products via Gothenburg. Much energy has accordingly been displayed in extending and improving the harbour and in the endeavour to consolidate the corporation's authority

over both banks of the Göta and its outlet so that the harbour plans as a whole shall be secured from outside influence. Not less important is the erection, now in progress, of powerful electrical works, which, with connections, will probably cost £350,000, or more. These will distribute current for lighting and power throughout the urban district, transform to suitable tension for different purposes the current from the station at Trollhatte, and serve as a reserve for the latter in cases of emergency. Already, there is a marked movement in the neighbourhood of the city in the establishment and extension of spinning and weaving mills and other works, in the operation of which electrical energy seems destined to play a very conspicuous part. In Stockholm, also, a new central station has been built, planned in view of a future transmission of power from Elfkarleo, a distance of 115 miles.

The building of railways was commenced late, but, once begun, was continued with remarkable energy. All the main lines have been constructed for and are owned by the State, which has also assisted, by loans or subventions, most of the other railways. At the end of 1905 Sweden possessed in actual use 7,865 miles of railway, of which 2,605 belonged to the State. Consequently, in proportion to population, Sweden has more railways than any other country in Europe. The rails are generally of British, German, or Belgian manufacture, but the rolling-stock, especially on the Government lines, is for the most part of local origin. A recent supply, however, was obtained from the United States. As fuel, English coal is chiefly used. With few exceptions, the railways are provided with but a single track, which has made it possible to reduce the cost of construction to a relatively low figure. The total capital expended on railway enterprise up to the present is about £50,550,000, on which average dividends have been paid exceeding by more than 1 per cent the corresponding figure for Europe generally. Some of the profits derived from the State railways are truly remarkable, as witness the following, quoted from a return for 1905, not only the gross and net income being considered, but also the cost of construction:—The Katrineholm-Nassjo line, through Ostergothland, 8.39 per cent; the Gellivare-Lulea line, practically for ore-transport only, 6.66 per cent, and the Stockholm-Gothenburg and Södertelje line 6.60 per cent. The gross earnings of the State railways in 1906 amounted to over £33,333,000, and those of the private lines to nearly an equivalent sum.

Great interest and hopes centre in schemes for a larger employment of electric traction. Already several electrically-driven railways, among them one between Helsingborg and Ramlösa, in the

southernmost province, are operating with considerable success, and it may with certainty be asserted that the movement has passed the experimental stage. During 1906 and last year, extensive investigations were pursued with a view to testing the feasibility and economy of applying electric traction to all the trunk lines south of Bollnäs, a place some 150 miles north of the capital. As a result of these studies, there has been prepared, under the direction of the Government, a very elaborate report, including exact calculations of cost, etc., strongly favouring the entire project, with the exception, for sundry reasons, of three relatively short and unimportant sections. As the most interesting portions of this report have already appeared in THE ENGINEERING MAGAZINE,* it is happily unnecessary for me to refer at greater length to the subject. It may, however, be pointed out that, inasmuch as the plans relate to no fewer than 1,700 miles of track, the project is, beyond question, the most important of its kind ever formulated. As such, it may be regarded as not inaptly illustrating the argument with which this article was opened.

There have been times when Sweden was foremost among the nations as regards iron and copper production. Although it long since lost this dominant position, the people have always maintained, both in mining and metallurgy, the highest of technical standards. Progress during recent years has been steady and phenomenal. In the decade ending 1900, the number of persons deriving their support from the mining industry and metal production increased by 50,000, and it is estimated that there are at present in the country at least 200,000 such persons. Whereas in the period 1871-5 the average annual production of ores and minerals (except stone) was 939,092 tons, the production in 1902 was 3,536,759 tons, in 1908 3,678,000 tons, and last year considerably exceeded 5,000,000 tons. Of this increased output some details will be found in the following table:—

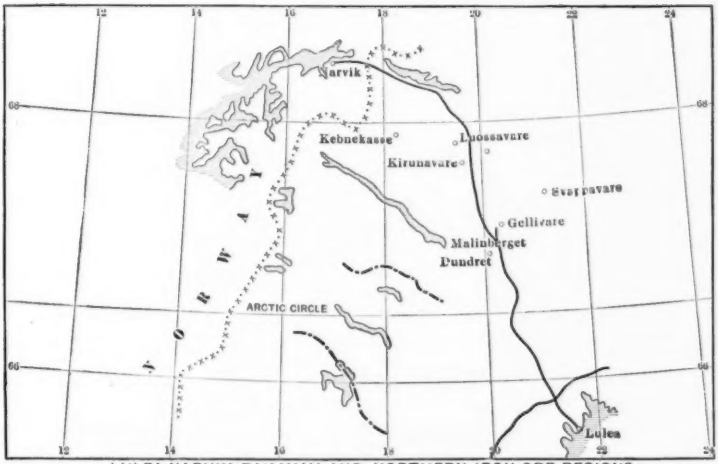
MINING OF ORES AND MINERALS.

Metric tons of 2,204 lb.

	Average, 1871-5.	Average, 1896-00.	In 1905.
Iron	795,263	2,294,760	4,365,967
Iron pyrites	.....	450	20,762
Coal	50,396	235,626	332,384
Lead and silver	10,949	8,644	8,397
Copper	44,273	23,590	39,255
Zinc	30,539	57,701	56,885
Manganese	488	2,487	1,992

In central and southern Sweden the principal ore regions are concentrated within an area of some 5,800 square miles, stretching from

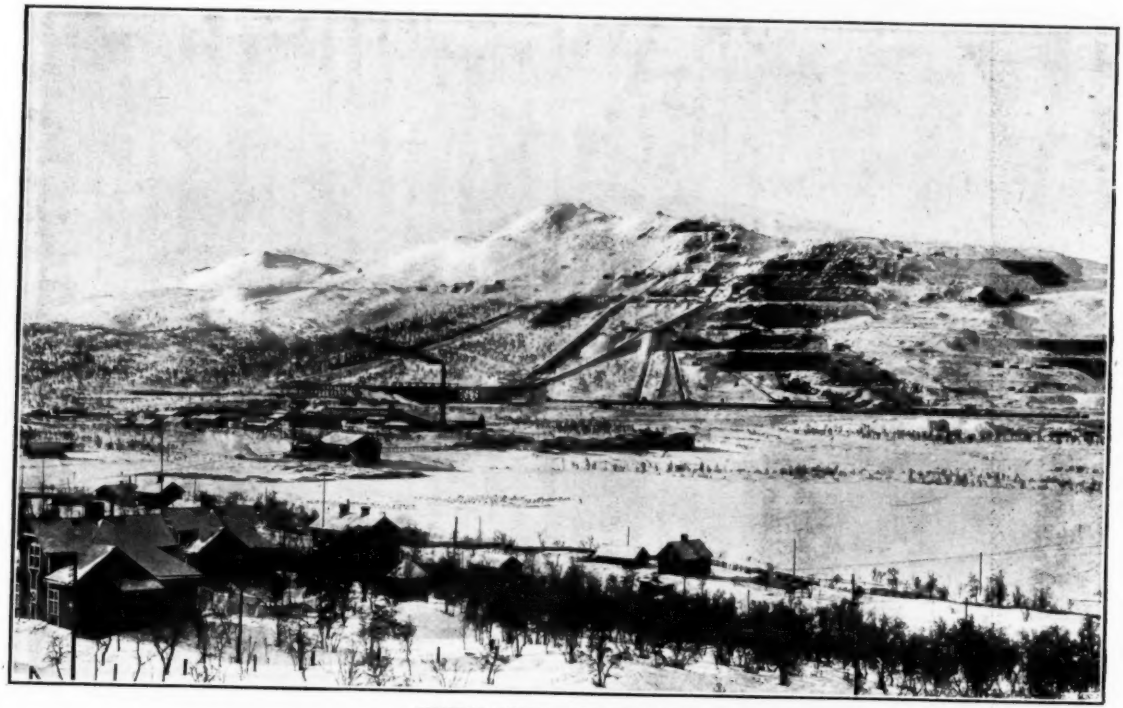
* The Electrification of the Swedish State Railways. February, 1908.



LULEA-NARVIK RAILWAY AND NORTHERN IRON-ORE REGIONS.

the southernmost part of the Gulf of Bothnia in the east to the north of Lake Venern in the west. North of this region, however, ores of different kinds occur, the most important being the deposits in Lapland, from one-half to one and a half degree above the Arctic circle —these being, in respect of length, thickness and percentage of iron, among the richest in the world. Until within the last four years, of the ore-fields in this region, one only, that of Gellivare, was worked on a large scale. Now, however, since the extension of the Lulea-Gellivare railway to the Norwegian port of Narvik, which is free from ice all the year, an active and increasing production of ore is recorded from the practically inexhaustible supplies of Kirunavara and Luossavara. During 1906 the quantity of ore from Gellivare shipped from Lulea was 1,216,780 tons, an increase of nearly 145,000 tons as compared with the preceding year, while from the more recently opened fields 1,558,635 tons were transported by rail into Norway and shipped from Narvik. The latter amount would, doubtless, have been exceeded but for the special rates payable to the railway for traffic beyond 1,200,000 tons yearly, a regulation which came into force in 1906 and the wisdom of which is open to question.

During last year the average number of workers engaged in actual mining operations on the properties of the Luossavara-Kirunavara Company was 1,217, the total amount of ore transported over the railway and shipped from Narvik being 1,407,298 tons. This exported



GENERAL VIEW OF KIRUNAVARA.
Photograph by Erland Groth, Kiruna.

PART OF THE KIRUNAVARA WORKINGS.
Photograph by Erland Groth, Kiruna.

ore included four standard qualities, analyses of which showed the following results:—

Quality A	0.028	per cent.	phosphorus,	69.61	per cent.	iron.
" C	0.255	"	"	"	68.19	"	"	"
" $	1.91	"	"	"	62.20	"	"	"
" G	2.90	"	"	"	56.07	"	"	"

VALUE OF EXPORTS AND IMPORTS—METALS AND MINERALS.

In Pounds Sterling.

Exports.

Iron and Steel:	1895.	1905.		1895.	1905.
Iron Ore	311,278	1,516,440	Coal and Coke	1,803,440	2,775,220
Pig Iron	199,890	489,830	Iron and Steel, unwrought and partly wrought.	180,660	432,400
Bar, Bolt, Hoop, etc.	1,296,000	1,890,440	Manufactures of	524,500	1,194,110
Blooms	125,500	300,160	Machinery, including Locomotives	619,440	1,314,000
Plates	30,220	21,400			
Iron and Steel Wares	350,000	861,550			
Iron and Steel Wire	19,450	30,770			
Machinery	307,000	859,000			
Zinc Blende	64,330	194,110			

During the period 1871-85 the value of the imports greatly exceeded that of the exports, but since then the ratio of exports has

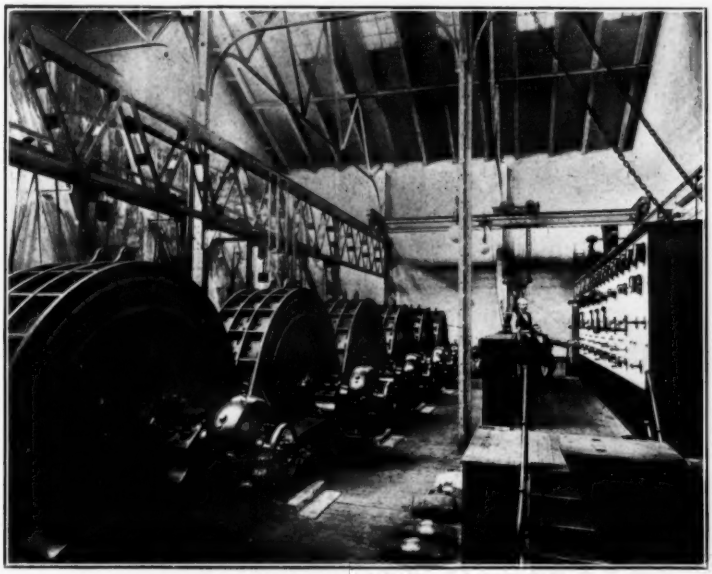
THE DOMNARFVET PAPER WORKS.

risen considerably, and this notwithstanding the ever and largely increasing imports of coal. The necessity of the latter is a dominant factor in the industrial development of the country and has been the cause of many ingenious expedients for augmenting the supply of inland fuel. On all sides, however, it is recognised that the problem must be solved by a larger utilisation of the vast amounts of water-power available in practically every section of the country.

Of the total land area of Sweden, not fewer than 52,000,000 acres, or rather more than 50 per cent, are estimated to be covered with timber. It is to this circumstance that we must look for a deciding influence on the development of the nation's iron industry, for the fuel used in the production of iron is principally charcoal and wood—often mixed, however, with fossil coal or coke, or peat or peat-coal, in the producers for open-hearth furnaces, in puddling furnaces, and in the making of blister steel. Moreover, of the value of Swedish ex-

INTERIOR OF DOMNARFVET PAPER WORKS.

ports, more than one-half must be credited to forest products—unwrought and wrought timber, pulp and paper. From these facts it will be obvious that no inquiry touching the economic and industrial position of Sweden is possible without reference to its wealth-producing forests. These, during recent years, have been directly responsible for much engineering activity, and we may confidently anticipate that this relationship will continue and become increasingly close.



THE POWER STATION AT DOMNARFVET PAPER MILLS.

Notwithstanding Sweden's forest resources—superior in extent and value to those of any European country other than Finland—it is estimated that even now the annual consumption of timber exceeds the growth capable of being used by nearly 4,000,000 cubic yards. That the proportion is not more serious is due in large measure to the prescient legislation of recent years, which, in effect, decrees that no timber shall be exported or sawn up at saw-mills unless the trunk at a certain height is of specified diameter; that for every tree cut another shall take its place; and that, after lumbering, the ground shall be treated in such way that the regrowth of wood is not endangered. Something more, however, might yet be done in improving communication, whereby the wood-material in more or less inaccessi-

GUSTAFSBERG SAWMILLS, NEAR SUNDSVALL.

ble parts might be better utilised, and by putting into a wood-producing state heaths and other, at present, unproductive territory.

To illustrate the growth of the industry, a few figures may here be given. In 1821 (the year of the first reduction of custom duties in England) Sweden possessed 3,633 saw-mills, with an output of 267,000 dozen deals and boards, of which 200,000 were exported. Forty years later, she owned 59 steam and 4,933 water or wind saw-mills, and the export of deals and boards alone amounted to 1,478,000 dozen. In fifteen years more, this export was trebled, and the exports of rough timber rose to over £5,500,000. In 1903—a record year so far as regards unwrought, *i. e.*, sawn or hewn, timber—the exports classified under this head exceeded £9,600,000 in value; and in 1905 the value of exports associated with the country's forest resources approximated to £13,000,000, including wood pulp £2,566,000, paper £5,330,000, matches £480,000, and joiners' wares £590,000. There were in operation in 1900 1,148 saw-mills, ranking as factories and employing 43,312 workmen; 1,835 saw frames and 769 planing machines were in use, and, as motive power, 536 water wheels or turbines and 859 steam engines were employed in the mill-work proper and 10 water wheels and 109 steam engines for running electric motors. Since the last census there has been an almost continuous boom in erecting and enlarging mills, equipped with the most modern machinery; consequently all these figures are inadequate.

The principal saw-mills are situated north of the river Dal and adjacent to the Gulf of Bothnia, the most notable in regard to the export trade being those in the Sundsvall, Hernosand, Hudiksvall, and Gefle districts. The wood-pulp and paper mills and match and pasteboard factories are, on the other hand, mostly located in the southern provinces, a prominent exception being the Domnarfvet paper mill, of which illustrations appear in the present article. This mill is the property of the Stora Kopparbergs Bergslags Aktiebolaget, probably the oldest industrial corporation existing in any country, the owners, also, of the historic Falun copper mine, the great Domnarfvet iron works, 750,000 acres of forest, the largest saw-mill in the world, and an important wood-pulp factory at Skutskar, and a recently erected combined pulp factory and paper mill at Kvarnsveden.

It will be my duty, in a subsequent article, to refer in some detail to the more important features of the movement discussed in the preceding pages, to its international significance, to recent progress in hydro-electricity and other departments of engineering, and to the operations of typical industries and establishments in promoting and profiting by Sweden's new, progressive, and interesting departure.

GENERAL VIEW OF THE SANDVIKEN IRON WORKS.

THE PRODUCT AND METHODS OF EUROPEAN LOCOMOTIVE WORKS.

By Charles R. King.

Mr. King's review of Continental locomotive design, steam practice, shop methods, and mechanical devices began in our issue for June. The data since received concerning the new processes of welding, and especially the details and illustrations of machine operations in the Italian works, have made it necessary to divide the remainder into two portions, instead of finishing in this number as first intended. The August installment, concluding the study, will deal with the latest Italian work and some interesting examples of Roumanian, Russian, Belgian and other practice.—THE EDITORS.

SWISS railways have adhered for years to the de Glehn engine arrangement or its modifications. The view on page 520 shows the first of the Central European type introduced into Switzerland. It has bar frames and the Clench superheater in the boiler barrel. The engine is the Maffei standard compound arrangement with his new inlet valves on the low-pressure cylinders for automatic admission of steam when starting a train. The cylinders are shown in the view Figure 21. The receivers do not connect the cylinders direct as in the Bavarian and Baden engines, but are formed of pipes passing through the smoke-box. The inlet-valve chambers are visible projecting one from each of the two ends of the low-pressure cylinders. Figure 22 is a view of the boiler. It has sextuple-riveted longitudinal seams and double-riveted circumferential seams. The saturated steam collector is in the rear barrel and the superheated steam dome and manhole is placed on the forward barrel over the superheater. The superheater simply consists of the forward end of the barrel partitioned off as a reservoir of superheated steam traversed by the flues. The position of the intermediary tube plate in the forward barrel is easily distinguishable by the second row of rivet heads. The great antiquity of this invention, as also of the U bent smoke-tube superheater, will be understood from the fact that this form of superheater figures incidentally—as would a chimney or a firebox in a locomotive boiler—in the French patent of Emorine, No. 13246, April 2, 1853. In this old superheater and in this latest arrangement of the Clench, the throttles are placed between the superheater and the cylinders so that the same steam pressure is always maintained in the superheater drum as in the boiler

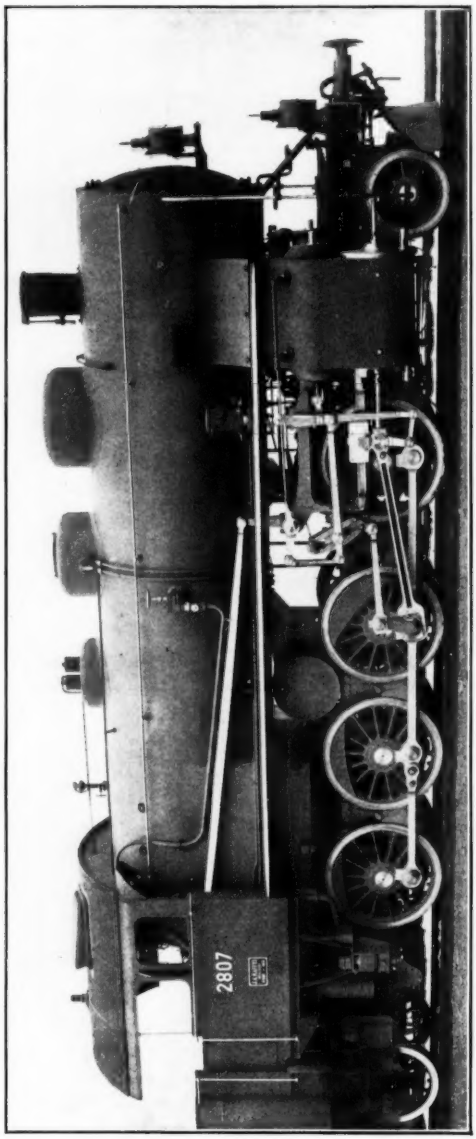


FIG. 20.* BALANCED COMPOUND WITH CLENCH SUPERHEATER, FOR PASSENGER AND FREIGHT, ST. GOTHARD RAILWAY.

proper a most important detail; if it be absent, much capital is made of the fact by advocates of rival systems. The Gotthard Railway is so highly satisfied with the results of this Clench modified apparatus that, until future notice, it will be a standard application for all Gotthardbahn locomotive boilers. The temperature of steam attained in service with these superheaters is 260 degrees C. and this is in part due to the action of the three vertical partitions within the drum; the holes in the partitions through which the steam passes from one compartment to the other, around the flues, are only slightly larger than the flues—52:61 millimetres—so that the steam is compelled

* The figure numbers are consecutive with those in Mr. King's first article.

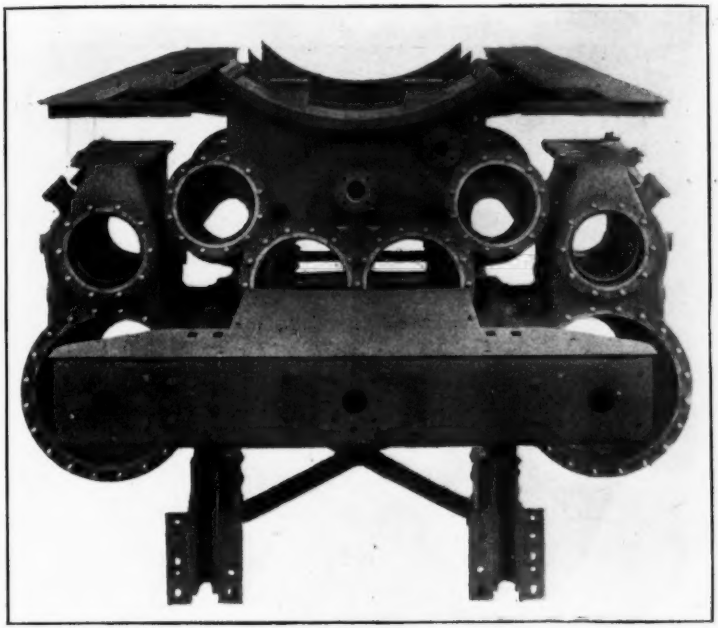


FIG. 21. CYLINDER CASTINGS FOR ST. GOTTHARD MOUNTAIN LOCOMOTIVE.

to circulate on the surface of the tubes. One of these new locomotives replaces two of the machines hitherto employed for hauling accommodation passenger trains on the slopes of the Alps. They are very powerful machines for their weight and are doing excellent service. Supplementing the first lot of eight machines a further lot of eight is on order from Maffei.

For light haulage work the motor-car engine has been carefully studied by many locomotive builders, including Maffei. This class

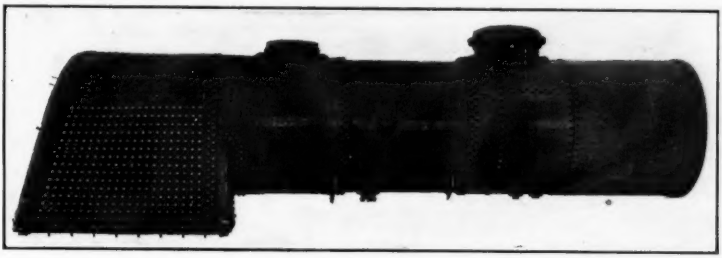


FIG. 22. BOILER WITH CLENCH SUPERHEATER, ST. GOTTHARD MOUNTAIN LOCOMOTIVES.

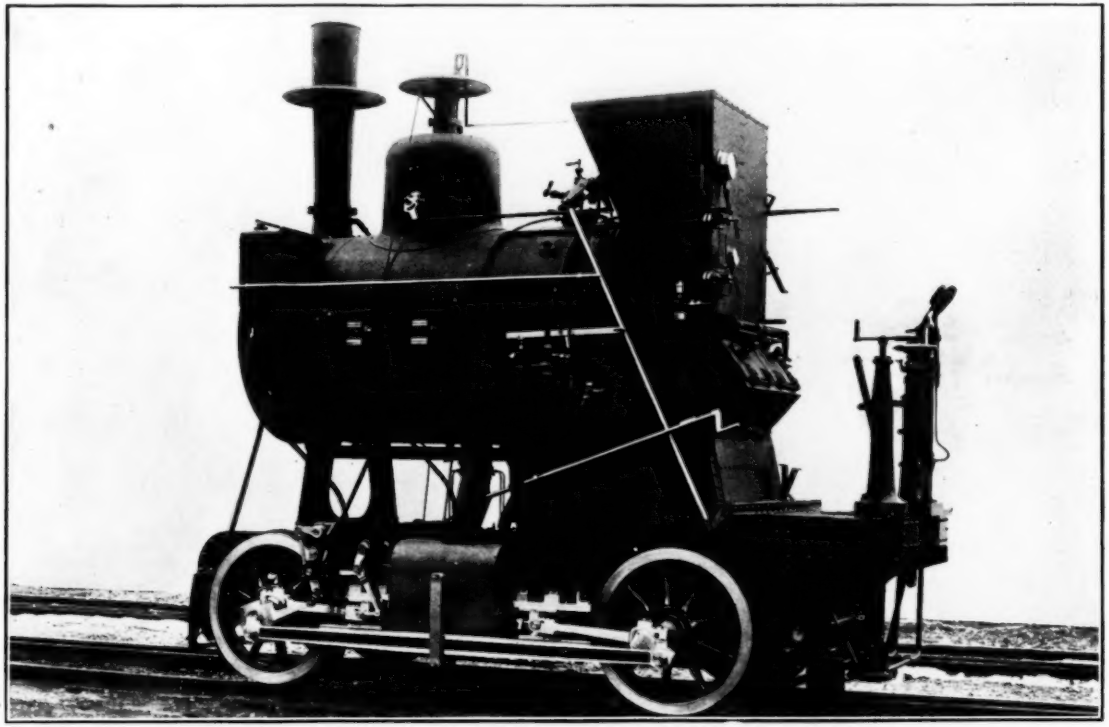


FIG. 23. CAR MOTOR FOR TRUNK LINE TRAINS; TWO CYLINDERS, TWO VALVES, FOUR PISTONS, FOUR CRANKS; BALANCED EFFORTS. Schmidt superheater, automatic stoker.

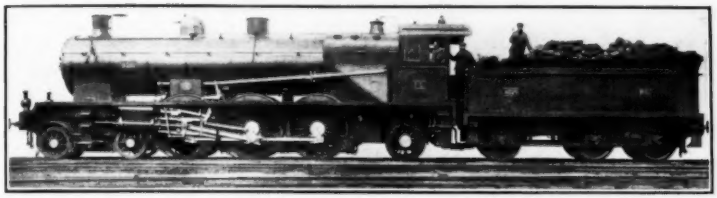


FIG. 24. NEW PACIFIC-TYPE LOCOMOTIVE, PARIS-ORLÉANS RAILWAY.
Four-cylinder compound; feature, tapering mud ring and firebox.

of engine is built at Munich to be both dependent and independent of the car body. The boilers are both of the water-tube type, Turgan's patent, and of the ordinary locomotive type—see Figure 23. They have hoppers for the fuel and automatic firing arrangements. Superheaters of the Schmidt type are also fitted. The engines are entirely novel, there being four pistons in two outside cylinders, which are practically, in effect, the same as four cylinders. Steam is admitted between the two pistons and drives them apart simultaneously, and then it is admitted against the outer faces of the two pistons, driving them towards each other again. The object is to secure complete equalisation of the forces, by opposing one effort to another that is exerted in the opposite direction and thus avoiding the thumping so well known to passengers riding over two-cylinder engines when the car is slowly mounting a grade. The engines of the independent locomotives for light services or branch lines are made in precisely the same way, the only difference being that the "side-rods" are placed inside the frames—a novelty in locomotive construction. In the motor-car engines the coupling rods are, as shown in Figure 23, fitted on the cranks outside of the driving rods and in such way as to rise and fall on the outside of the cylinder casing.

French Railways. Paris-Orléans. The *oo OOO o* type locomotive of the Paris-Orléans line, Figure 24, began service in 1907. It is remarkable for its cone-shaped firebox. The object of this unusual arrangement was to contrive a box of the wide type having its most important advantage, of facility in firing, and yet with the ordinary narrow firebox flue sheet in front. Against wide tube sheets much is said among railway men; much also is written against the wide firebox altogether, but very often such adverse criticism is traceable to some commercial interest in arrangements favored by narrow fireboxes—and of such it may be said that literature based upon interest in the commercial advancement of certain specialties has little scruple with regard to truthful foundation. Even in England, the North, the Brighton and Western Railways have commenced the practice of wide

fireboxes—and the Brighton is very satisfied with them. The Orléans has sought an improvement on the type, and in service the fact that for six months no remark or complaint has been forwarded to headquarters relative to the new boilers is considered to be a very good augury—enginemen and locomotive dépôts abhorring changes. The plan of the firebox is very clear in Figure 25, and is all the more so if the reader will take the trouble to view the engraving the wrong way up. The arrangement was proposed by Mr. Guth, the new director of the engine department of the Société Alsacienne de Constructions Mécaniques, and accepted by the chief of motive power, Orléans Ry. The form is new, but the principle old. In 1899 Cockerills of Seraing, Belgium, built for the Belgian State lines, and showed at the Paris Exhibition, their remarkable *o OO o* type having the genuine wide Belpaire firebox, but with somewhat less than half its length at the forward end contracted, between the high driving wheels, to little more than half the full width. The forward end of the firebox is fitted between the frames near the rear driving wheels. The same effect is realised in the new conical-plan boxes of the Orléans line.

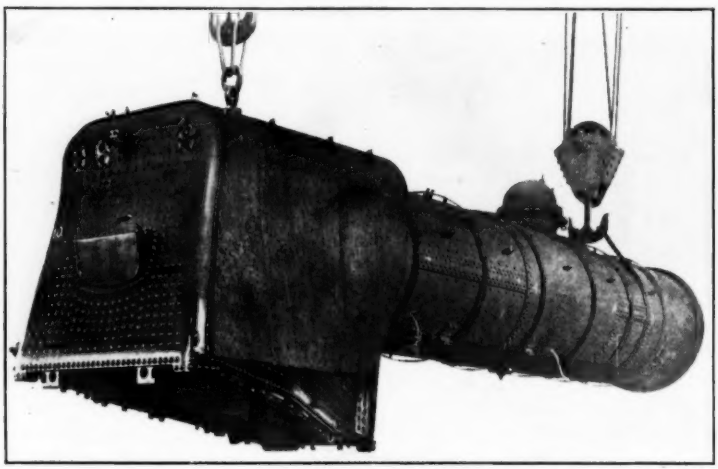


FIG. 25. PARIS-ORLÉANS LOCOMOTIVE BOILER SHOWING UNDER SIDE OF TAPERING FIREBOX.

The new boilers, with heating surfaces of 15.37 square metres in firebox and 241.88 square metres inside flues, and working pressure of 16 kilogrammes per square centimetre, weigh 24 tons complete with chimney and ash pan. The latest plan for riveting all the seams is best seen in the view of the boiler. The firedoor is of the inwardly-opening type, which will probably become obligatory in

future, as it closes of itself when, as the result of accident, steam rushes into the firebox. The frames are illustrated in the Figure 26. It will be observed that they are strongly reinforced where cut out to clear the front end of the firebox. Complete, as shown, and with yokes or balance levers for the springs, but without draft beam or spring draft and buffing gear, the frame weighs 10 tons. In the engine proper are to be noted points of relative novelty for French practice, that is, the approaching nearness of the inside and outside cylinders, the construction of piston valves by a firm which, with Mr. de Glehn, had so long adhered to flat valves, and the removal of the characteristic steam pipe from the outside into the smokebox.

FIG. 26. PARIS-ORLÉANS LOCOMOTIVE FRAMES FOR PACIFIC TYPE.

Elsewhere in France no change in engine design is yet pronounced, but there are indications that one line—the Ouest—may in future experiment with the simple four-cylinder arrangement common elsewhere on the Continent and against which no substantial objection can be produced by French designers—other than that entailed by strong attachment to the now out-of-date but original divided system of the late Mr. Webb. The "Est" Railway is now drying the steam in its passage through the receiver from the outside high-pressure group, set back on the frames, to the forward low-pressure group between the frames. This defective Webb-de Glehn arrangement of the cylinders facilitates condensation. Consequently the "Est" passes the steam all around the inside contour of the smoke-box in four parallel pipes, instead of in one as usual. This dries the steam, which need not have become moist were all cylinders grouped in one block. A saving of about 4 per cent is credited to this arrangement; but those responsible for the "drier" do not consider the figures to be yet proved. Mr. Drummond, the veteran motive-power chief of the

English South-West Railway, delivers steam from boiler to cylinders through thirty small pipes instead of two, as in the conventional arrangement; and admits that while it is a favorable detail for the engine there is no claim to make for any distinct economy.

The new processes for welding have been of the greatest utility for the work of railway shops, for they permit of the metal being fused *in situ* without having to dismount the parts to be repaired. Even a broken bridge in the orifices of a valve-chest liner can be sometimes "touched" with the flame and the liner then rebored in place. In the work of new constructions these welding processes are largely employed. At the La Chapelle (Paris) shops of the Nord Railway the oxyhydric process is in use for welding all thin plates not subject to special working strains. Boiler flues are pieced together and frame plates are welded or soldered, after being fractured in service. For joining the clothing plates of boiler or cylinders —which require to be hermetic when no non-conductor is used for lagging the boiler—it is especially serviceable. A length of 1 metre of 1-millimetre thick plate is welded in 10 minutes, consuming 20 litres of oxygen and 100 litres of hydrogen and costing, together, 14 centimes = barely 3 cents; one metre of 2-millimetre plate is soldered in 15 minutes, consuming 60 litres oxygen and 280 litres hydrogen. The proportion of hydrogen is much above the theoretical value in order to avoid oxidation. Frame plates or parts attached, are repaired with a consumption of gas differing widely in proportion to the importance and difficulty of the operation. For instance, suppose a crack 5 inches long in the angle of horn-plates or axle-box guides ("pedestals"), the depth being 1¼ inches. The metal to be run into the cavities, that machined inside and outside to half-depth, calls for an expenditure of 1,500 litres of oxygen and 8,800 litres of hydrogen, costing 11.39 francs, say $2.28. The removal of the plant, its installation, the welding, and the return of the plant, takes the smith and his help 2 hours, costing 2.45 francs, so that the whole repair comes to 13.84 francs.

The process is also employed in the construction and repair of steel and iron pipes, of ash-pans, locomotive footplates, and for all kinds of repairs where the flaws are superficial and compromise neither strength nor safety.

The outsider, in watching the process, sees the operator wearing dark spectacles holding the burner against a 1¼-inch frame plate. The flame first blisters superficially; the iron then gradually becomes a blotchy red, losing color directly the flame is moved away, then reddening through the whole depth of the metal, and finally becomes

white and attains the point of fusion, when the soft iron rod to fill the cavity is introduced and fuses with the neighboring metal of the plate being welded. With boiler flues the two coned and hollowed ends of the tubes are lightly butted together while resting on a X-trestle, and the operator touches the joint with the flame forming a series of little fused points, turning the tube slightly with each touch of the flame. Each operator welds 120 flues daily, or an average of 5 minutes per tube, the cost in gas for each 10 tubes being 100 litres oxygen and 650 litres hydrogen, costing, together, 81 centimes or 16 cents. The saving as compared with the old system of brazing amounts to 40 centimes (8 sous or 8 cents) per tube, or enough to pay for the gas required to weld 5 tubes.

An assistant removes the welded tubes and passes one extremity of the flue through a hole in a block, leaning on the other extremity, turning the tube slightly at each pressure. The tube, according to the foreman, never breaks at the joint but gives way at any other part if the tube is tested to destruction.

Summing up the price of shop work in connection with this form of welding, each tube costs 32 centimes, or 6½ cents, for labor; that is, cleaning and cutting down old tubes, sawing off and chamfering the new ends for the firebox extremities, welding, straightening; tests in the block and at the hydraulic press, and trials at the store reception. The gas costs 0.81 centimes per tube, consequently each tube thus welded costs, altogether, 40.1 centimes or 8 sous or cents.

The saving by this process for welding ribbed tubes of the Serve pattern is even greater—that is 13 sous or cents per tube. The ends of the tubes are hollowed and coned as usual, the lip on the hollowed end furnishing the metal for the fusion of the joint. Each tube-weld necessitates 60 litres oxygen and 243 litres hydrogen, together worth 37 centimes or 7½ cents. Each installation turns out 60 welded tubes per day or an average of 10 minutes for each ribbed tube, for which 4 sous or cents per tube is allowed. The entire cost per tube amounts to 25 sous or cents—one shilling—in including cleaning, selecting, and cutting down of tubes, removal of ribs at the extremities, sawing off the new end, chamfering the joints and, at the same time, removing the ribs near to the weld, welding, straightening and testing.

The two kinds of gases are delivered in steel cylinders of 47 litres capacity and at a pressure of 150 kilogrammes per square centimetre. Reduced to atmospheric pressure, each cylinder therefore contains about 7 cubic metres of gas, for which 16 sous or cents is paid to the "Société L'Oxhydrique Française" per cubic metre of hydrogen and 58 sous per cubic metre of oxygen. For thin metal up to 3 mili-

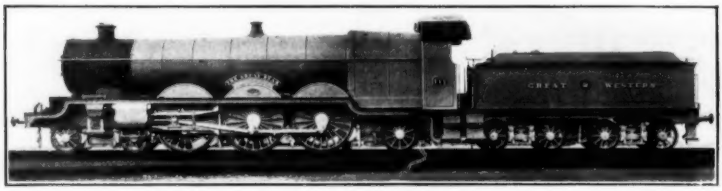


FIG. 27. GREAT WESTERN FOUR-CYLINDER NON-COMPOUND LOCOMOTIVE.

metres thickness this process is at quite as economical as the oxy-actelenic process of welding, but beyond that thickness the latter is the more economical. This latter process is largely employed at the Epernay works of the Eastern of France Railways. By reason of its less intense whiteness the glare of the oxyhydric flame is said to fatigue less the eyes of the operatives.

English Great Western. The new *oo OOO o* type Great Western locomotive, Figure 27, is a four-cylinder single-expansion engine of the divided arrangement of cylinders and driving axles. The boiler is notable for the authentic type Belpaire wide firebox, and the Cole superheater in the boiler combined with a Swindon arrangement of the collector reservoir for the superheated steam. The brick arch is supported upon water tubes as in American practice. The heating surface of the boiler is 2855.8 square feet, and of the superheater 545 square feet. The grate area of only 41.8 square feet is not disproportionate, with the immense calorific value of the coal used by engines between London, Bristol and Plymouth, and which, under best conditions, evaporates 12 pounds of water, while the average quality of coal for express locomotives varies between 10½ and 11 pounds evaporation. The laboratory test of the evaporative value gives 15 pounds per pound of Welsh steam coal, which is equal to a little over 15,000 B. t. u. per pound. Besides good coal, there are other conditions which tend to make this largest European express locomotive more powerful and efficient than Continental engines of the same dimensions, such for instance as softened water, first-class upkeep, and scrupulous attention to the trimming and cleaning of the machine. Under the very inferior conditions of ordinary routine care and attention so often prevailing on the Continent the best of coal-saving devices and systems often work at waste, except during the period of trials when men and machine are made to do their utmost according to the urgency of the issue—as where the figures thus realised are required for publication in proof of the superiority of any marketable article.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

I. TYPICAL INEFFICIENCIES AND THEIR SIGNIFICANCE.

The progress of developing and segregating a new field of engineering—that which is occupied with directing the great forces of *manufacturing* to the greatest advantage and economy—has been marked by several great productions in professional literature which have established new ideals and have themselves become classics. Such were Mr. H. F. L. Orcutt's papers on Machine-Shop Management, and Mr. C. U. Carpenter's two series on Profit-Making Management, all published in this Magazine. Such was Mr. F. W. Taylor's world-famed study of the Art of Cutting Metals.

We believe that this preaching of Mr. Emerson's new gospel of efficiency marks another such era, and that his articles will form another of the great volumes in the library of Industrial Engineering.—THE EDITORS.

NATURE'S operations are characterized by marvelous efficiency and by lavish prodigality. Man is a child of Nature as to prodigality, but not as to efficiency. If it had happened the other way—if he had followed Nature's lead as to efficiency, but had taken up parsimony as a distinctly human virtue—the human race would have become wealthy beyond conception.

Most political economists have preached parsimony, not efficiency. As parsimony is not one of Nature's teachings and as efficiency is, it would be better to aim at efficiency first and leave parsimony to the generations to follow, who will be forced to make a virtue of necessity.

The efficiency of Nature's operations is seen on every side.

There is Nature's pump, which draws up the water from the surface of the ocean to a vast height, carries it thousands of miles and deposits it on mountain tops and over plains. No reciprocating parts, no valve slip, no lost motion, no frictional resistance, no pipe lines. Prodigal in the amount sucked up, prodigal in the height to which it is lifted, prodigal as to distance transported, but as a pump proposition a perfect heat cycle.

There is Nature's storage battery in muscular reserve. A salmon will enter the Rhine from the sea, cease feeding after entering fresh water; he will swim up stream 500 miles, in exceptional cases stay at the headwaters for 17 months, and then, not having lost much weight, will swim to sea again.

An oil engine may reach 30 per cent of thermal efficiency, but the salmon, assuming his whole weight to be pure oil, stores at least several hundred per cent more than thermal efficiency.

The salmon uses stored, not thermal, energy.

The fire-fly, the glow-worm, the phosphorescent jelly-fish, show a far higher light efficiency than has ever been reached even by vacuum lamps.

A heavier-than-air flight of 23 miles is the limit thus far attained by man; but most of Nature's visible creatures, from the midge to the heavy swan, revel in mechanical flight. From swans to humming birds, innumerable feathered creatures fly every spring from the tropics to the Arctic circle, every autumn from Arctic circle back to tropics, while some of them fly from Arctic to Antarctic.

To attain the high efficiency of stored energy of the fish, the high mechanical efficiency of the bird, the high lighting efficiency of the fire-fly, is not an ethical or financial or social problem, but an engineering problem, and to the engineering profession, rather than to any other, must we look for salvation from our distinctly human ills, so grievously and pathetically great.

Inefficiency, principally of administration, is alone responsible for the long bread line of able-bodied men, which during this winter, spring and summer honors Mr. Fleischman's generosity, but disgraces New York City. Inefficiency, principally of administration, is alone responsible for the 700 starving children, fed daily at the East side schools in New York.

For every mouth that comes into the world, there are two hands, two feet; and, if each set of hands and feet does not have an organizing brain to direct it, there are occasionally great creative and organizing minds, whose province, whether they know it or not, ought to be to enable the hands and feet to forestall bread lines and infant starvation.

When one considers such products of engineering knowledge and skill as a first-class ocean steamer, with its perfection of design, its perfection of machinery, its perfection of line and staff organization; or when one considers a modern New York office building, the Hudson Terminal for instance, where one finds without any futile or inept talk, discussion, or legislation, a harmonious and smooth-working combination and aggregation of intense individualism, intense socialism, intense communism—and even intense anarchy, since all the tenants come and go as they please—one realizes that it is to engineering knowledge and practice one must look for redemption from existing evils. Men, women and children starve, not because there is not abundance and plenty, not because the few have appropriated the portion of the many, but because there is such tremendous waste. The actual and potential wastes in each year amount to as much as the total accu-

mulations of wealth, and if all the possessors of accumulations should be left in undisturbed possession, and the wastes of current production and use be eliminated and equitably apportioned according to meed and deed, no woman or child would have to do mill or factory, store or office work, no old man or woman would have to toil, no young man need delay his marriage, nor any head of a family be torn by anxiety as to the feeding, clothing, or housing of his dependents.

It is distinctly the business of the engineer to lessen waste—wastes of material, wastes of friction, wastes of design, wastes of effort, wastes due to crude organization and administration—in a word, wastes due to inefficiency. The field is the largest and richest into which any worker was ever turned.

Progress—absolute, not temporary time-serving—will be made slowly or rapidly as the ideals and standards are high.

The field is large and rich because so little is being done, because there is so much to do.

Very few, outside of those who have made special investigations, realize how very low the average efficiency of endeavor is, even in a highly civilized country like the United States. Everywhere we see brilliant results; rarely can anyone follow the losses between result and initial supply.

We are all familiar with the light from an electric incandescent film in a bulb. We know that usually the power revealed in the light comes from coal found in mines. The human endeavors, in producing light from coal in the mine, to worker's table, can be followed both absolutely and comparatively.

We can assume the fire-fly to have attained 100 per cent standard; not absolute, but a standard that engineers might expect ultimately to attain. That the fire-fly is 1,000 times as efficient in combined economy and production is scarcely believable, yet a rough analysis of fire-fly light and of bulb light from coal will show this to be the case.

A worker requires on his table, for least fatigue and detriment to the eyes, a certain amount of light. As the sun does not always shine, as winter days are short, as some rooms are at the bottom of air shafts, artificial light is needed. Electric light is most convenient and safest. What is the efficiency of production of electric light compared to the efficiency of the fire-fly, which will be called 100 per cent standard?

The fire-fly's source of light is the hydrocarbons contained in what it has eaten. Man's source of light is the hydrocarbons in coal.

The fire-fly finds its food with about the same facility that it finds the oxygen it breathes. Man finds oxygen without expense, but there

are enormous wastes between coal in mine and coal entering furnace door. Of coal owned in ground, half the seams are not mined but ruined, and at best 75 per cent is recovered from the seams that are mined. This reduces the mined coal to 37.5 per cent of the total coal destroyed in mining. The workers and machines are inefficient all the way from coal seam, through mining and transportation, to furnace door. This adds unnecessarily to cost. The efficiency of purchase price is only 70 per cent. In furnace, boiler, engine and generator at best only 10 per cent of coal energy appears as electrical energy. The fire-fly's conversion of hydrocarbon into energy is on a basis of 40 per cent. Of the electrical energy only 5 per cent is recovered as luminous energy.

From supply to light emitted the fire-fly shows a continued use, transformation and luminous efficiency of 100 multiplied by 0.40 multiplied by 0.30, equals 30 per cent. Man shows 37.5 multiplied by 0.70 multiplied by 0.10 multiplied by 0.05, equals 0.013125 per cent, or a little over ⅛ of 1 per cent. The fire-fly is more than 200 times as efficient.

The fire-fly effects two further very great economies; it flashes its light only for the time actually needed and it also flashes it for the benefit of eyes made exceedingly sensitive by darkness. These economies we need not consider for ordinary working illumination, although both of them are very effectively used in the theatre and in biograph exhibitions.

Man usually produces ten times as much light as is needed and wastes 90 per cent of it. The fire-fly producing light with one two-hundredth part of the hydrocarbon used currently by man, gets along with one two-thousandth of the light used by man.

If any human activity is followed out from initial reservoirs to final attainments, a similar sequence of losses will be found—losses gauged not by any ideal or unattainable standard, but by what is being continuously accomplished all around us. Even if, as yet, some of the high efficiencies seen in Nature are beyond reach, it is a greater reason for eliminating those wastes which are avoidable and which are primarily responsible for the starvation of men, women and children.

Not only are occurring wastes more flagrant than is generally admitted, but it is also not realized that very hard and extremely exhausting work is not an evidence of efficiency.

The fire-fly works comfortably; the miner and furnace stoker do not. Recently on the first of the hot summer days, I stood on the charging floor of an iron foundry in the middle West. It was a foundry far-famed for its advanced methods. Three men weary, haggard,

worn to the limit of human endurance, were throwing the pig, scrap, and coke into the cupola, yet in spite of their exertions they were working with only 33 per cent efficiency. Three days before we had observed two men, with less fatigue and effort, charge a cupola twice as large. What caused the 67 per cent inefficiency? The tracks for the cars bringing up the supplies of pig, scrap and coke, were so located as to the single cupola door, that three men were required to charge. One lifted a pig from the car, passed it to his companion who swung it to the third man who threw it into the cupola. This had been going on for twenty years. At the other foundry, there were two cupola doors, the car came up so that each man unloaded, with minimum of effort, directly from car into cupola.

That men should work very hard for 9 or 10 hours per day is not a hardship if they are interested in their work, or if, in the larger interest of the community, they work efficiently; but to work desperately hard for many hours at dirty, hot and rough work, yet waste 67 per cent of the time and effort, is unpardonable. What could not have resulted from an elimination of this waste?

1.—The product could have been cheapened.

2.—The men could have worked one-third the time and have accomplished as much.

3.—One man could have done all the work and have earned three times as much.

The benefits should however be distributed in all three directions. Fewer men should work less hard, receive higher wages, and deliver a cheaper product.

The inefficiency on the charging floor pervaded the whole of this foundry although it stands exceedingly high in its class. The proof of the general inefficiency in this foundry is evidenced by the fact that the other foundry turns out its finished castings for less than half as much per 100 pounds, labor, materials and overhead charges included.

It is not because men do not work hard but because they are poorly directed and work under adverse conditions that their efficiency is low.

Railroad repair shops throughout the country do not show 50 per cent efficiency on an average, as regards either materials or labor. When the particular jobs are picked out, similar or worse wastes to those of the charging floor, appear. An actual instance observed was as follows:

The foundry made, for a railroad shop, big cylinder bushings. These, after being machined in the railroad shop, weighed about 375 pounds, but the original casting weighed 1,780 pounds. It took three

days to remove 1,405 pounds of cast iron. It should have taken less than one day if the rough bushing had weighed only 600 pounds.

COMPARISON OF COSTS.

	As made.	Standard.
Weight, rough	1,780	600
Cost per pound	$0.04	$0.04
Total cost	$71.20	$24.00
Labor	3 days	1 day
Cost of labor, $3.00 per day	$9.00	$3.00
Machine charge, $2.00 per day	$6.00	$2.00
Overhead charges, $2.00 per day	$6.00	$2.00
Total cost	$92.20	$31.00

In this same shop the most efficient men were checked up and found to average only 60 per cent of actual output, compared to realizable standards. At the end of two years of persistent effort many of the best men were brought up to 110 per cent efficiency, but there were still men as low as 10 per cent as to actual output compared to reasonable standard—the same standard on which others realized 110 per cent.

In another big locomotive shop, a careful study of the machines which had been in operation for 20 years showed that the location of 75 per cent of them would have to be changed, so as to facilitate the orderly, effective, and economical progress of work from one to the other. This and other eliminations of wastes doubled the output, with less labor costs.

In consequence of general shop inefficiency and operation inefficiency due to similar causes, locomotive repair costs, on western railroads, run from $0.08 to $0.12 a mile; yet a most efficient superintendent of motive power on a large transcontinental road succeeded in dropping to $0.05 and had only touched the high spots, his well considered opinion being that $0.04 was reasonably attainable. On another transcontinental road, repair costs per mile were dropped from $0.1374 to $0.08 by persistent effort, but when the efforts were relaxed expenses immediately rose to $0.17. They should have come down to $0.06. Eastern and southern roads, with their small engines, better coals, and better waters, are not to imagine that they show any higher efficiency. They are on the whole worse.

It was a leading eastern road that established piece rates in its car shops and then limited the earning power of the men. When there was a sudden demand for increased car repairs, the limit was taken off and the men doubled their earnings. Then the limit was put back. Other eastern roads have also signally failed in attempts to increase the efficiency of their repair shops.

In a leading southern shop many men were receiving 12-hours pay for 3-hours work.

Coal wastes on railroads are almost as bad as labor and material wastes. On a very large railroad system, fuel charged per 1,000 tons of train weight per mile averaged 260 pounds; yet actual tests where all coal used was weighed, showed a consumption between terminals of only 80 pounds. This actual consumption could be doubled, be made 160 pounds, yet this standard be only 60 per cent of the actual wasteful expenditure.

The total amount of preventable material and labor wastes and losses in American railroad operation and maintenance approximates $300,000,000 a year—not less real, but more easily preventable, than the $600,000,000 of fire losses and fire-department expenses, which actually occur in the United States. This inefficiency of effort pervades to a greater or less degree all American activities.

Mr. F. W. Taylor, who has given twenty-five years to the minute and scientific study of inefficiency, and who as an incidental consequence developed high-speed steels, thus speaks of it.

"That the first-class man can do in most cases from two to four times as much as is done on an average, is known to but few and is fully realized by those only who have made a thorough and scientific study of the possibilities of men.

"This enormous difference exists in all of the trades and branches of labor investigated, and this covers a large field, as the writer together with several of his friends have been engaged, with more than usual opportunities, for twenty years past, in carefully and systematically studying this subject. It must be distinctly understood that in referring to possibilities, the writer does not mean what a first-class man can do on a spurt or when overexerting himself, but what a good man can keep up for a long term of years without injury to his health, and become happier and thrive under."

Inefficiency similar to that in the manufacturing shops exists in all building operations to the same or even greater extent. Mr. Taylor found a labor efficiency of only 28 per cent in the rough labor employed in the Bethlehem Steel Company's yards. The writer, by time studies, determined an efficiency of only 18 per cent in a gang of laborers excavating a foundation, and even less on some construction work in the erection of the large office buildings in New York.

The United States and State agricultural bureaus have determined similar inefficiencies in farming operations. The land was there, the effort was there; but owing to poor preparation of soil, poor planting, poor cultivation, the net results in such great staples as cotton, wheat, and corn, have been less than half of what proper methods, with the same climatic conditions, land and men, have since realized.

The agricultural stations and Mr. Luther Burbank, combined, have been doing for agriculture what Mr. Taylor and his disciples have been doing for the machine shops.

In our whole educational system there is the same inefficiency. Years are given to study, yet better results have been attained in months. In American schools the two main objects of education, amenities and discipline, are largely neglected; and instead an immense amount of time is consumed acquiring quantities of information of very low absolute or ultimate value.

Inefficiency is not a local evil. It extends through the whole of American life—extends through the whole industrial life of the world. The Chinese coolie, who as a daily task carries 100 pounds 27 miles for $0.27, is industrious and hardworking, but not more inefficient than the American railroad which moves a freight car an average of 23 miles a day, the cars at best, averaging only half loads per mile.

By a very inefficient use of his brain and muscles, the coolie carries the maximum load a maximum distance for a minimum price. The American railroad by the most advanced engineering and industrial methods carries an absurdly small net load for an absurdly small distance at an unnecessarily high cost.

Prevailing inefficiency is not a lapse from former virtue. We cannot praise "the good old times" when everything was done better. The coolie in spite of his many virtues is not better than the railroad whose charges per ton mile average only one-thirtieth those of the coolie. The difference is, however, that elementary though his methods are, the coolie has high standards, evolved during many centuries, but in Europe and America the railroad and the modern shop, using methods of great promise, have as yet no standards.

In tabulating inefficiencies it is not assumed that it is a human ideal to work hard all the time and to spend nothing.

The unit is the man. If he elects and can manage it, he can live in a tub, bask in the sun, and curtail his efforts and wants to a minimum. If he elects, he can work hard for days, weeks or months, and in short and riotous extravagance spend all he has accumulated. The fire-fly probably is chargeable with both extremes, but what is expected is that the man shall emulate the fire-fly in working efficiently when he does work.

Each nation has its own ideals, and the readiness with which the new ideal of efficiency can be assimilated and made effective, will depend on psychological rather than physical and mental traits.

The Japanese can equip their mills with American machinery and work on American materials. If in addition Japanese men are more quick to assimilate or to develop best methods, then indeed will the European and American, in the long run, lose.

MAXIMUM PRODUCTION THROUGH ORGANIZATION AND SUPERVISION.

By C. E. Knoeppel.

IV. BETTER DELIVERIES—MORE SATISFIED CUSTOMERS.

Mr. Knoeppel's initial article, in our April issue, reviewed the conditions under which the internal factory organization will work at its highest efficiency. The second of the series showed the results obtainable by proper system in processing, machining, assembly, and erection. The third dealt with economy in the use of materials and time. The present paper completes this series.—THE EDITORS.

IT was a wise man who decided to incorporate as a part of his letter-head: "Agreements subject to strikes, accidents, fires and other causes beyond our control"; but little did he think how many times it was destined to be used, not only to cover such cases as fires, accidents, and excusable causes, but many inexcusable ones as well. Today the clause above quoted is either on all business stationery or is taken for granted, and it is safe to say that nearly every business house uses it many times during a year to explain their nonfulfilment of promises. While I will grant that a manufacturer is often in no way to blame because he has failed to forward his shipment according to schedule, there are a greater number of times when no real excuse exists—unless perhaps it is carelessness, which of course would not be offered.

Every manufacturer who reads this article is a receiver of materials in some form as well as a shipper, and while the argument is intended more for the shipper than for the receiver of materials, we will start the discussion from the viewpoint of the receiver.

Is it not a fact, that almost daily you are disappointed in not receiving the notice of shipment, covering materials your works manager is anxiously awaiting?

Is it not a fact, that almost daily you receive in your mails about such replies as the following, in answer to your letters asking why the materials you have ordered have not been shipped as promised?

> "Yours of the 10th received. We regret to advise that owing to causes over which we had no control, we have found it impossible to make shipment as promised, but we expect to forward them about the 25th."

Is it not a fact that almost daily you or your assistants call up the freight offices, regarding certain materials which have been shipped, only to be advised—"nothing as yet"?

These are conditions that exist almost everywhere, and while they would not be worthy of more than passing consideration if they only ruffled a man's temper, as they sometimes do, they are entitled to careful attention as they directly concern the success of any manufacturing enterprise. You no doubt feel at times like doing business with some other concern than the one you are now doing business with, thinking perhaps that you might get better deliveries by so doing, which brings me to this question:

Do you as a *receiver* of materials, feeling as you do over your disappointment in not receiving notices of shipment—the letters of excuses and the statement, "nothing as yet", ever stop to consider that the receiver of *your* materials may be in exactly the same position as you are often in?

I will grant that you often look to those from you purchase, in order to make proper deliveries to your customers. Your customers, in their turn, whether they have their trade looking to them for shipments when promised or whether they are direct users of what they purchase from you, look to you for as prompt deliveries as possible, so that your success (in their eyes at least) depends to a large degree upon your ability either to make prompt shipments, or to convince them that their interests are receiving your best attention. If you cannot do this, you may be running the risk of having some of your business go to your competitors.

You may ask how can the maximum results be obtained in the way of getting shipments off according to schedule? The best results along these lines can be obtained only when proper attention has been given to conditions, present and future, before making a promise, and then the work has been followed watchfully until you *know* that you will be able to ship as promised, or that you will not be able to do so.

A promise cannot keep itself any more than a shipment can make itself, yet this seems to be the principle that so many work upon. I have known cases where promises to ship have been made and nothing more has been thought about them until letters were received asking for information as to the shipments, and as business courtesy demanded replies, the letter heretofore quoted was the result. I am therefore of the opinion that a promise composed of about one-quarter discretion in making and about three-quarters energy in fulfilling, will

go a longer way towards enabling the manufacturer to ship according to schedule than anything else. By "energy" I do not mean hustle and bustle, at the last minute, in an almost superhuman attempt to rush the work through the shops and onto the cars, in an effort to "make good," but an energy that is in evidence from the time the order is received and the promise made until the material is on the cars and finally at its destination. Any arrangement that will enable you to make deliveries as close to schedule as it is possible to make them should have your careful attention, for it will mean much in the way of more satisfied customers, better deliveries from those from whom you purchase, and lower costs through an increased production, all these being points which materially assist in making an enterprise successful.

It is very likely that almost every order you receive is accompanied by a request to state about when shipment will be made; is it not well to have some well defined method of procedure in filling your orders? It should need no argument to convince a manufacturer that the shipping of materials when promised is beneficial to the whole business structure. How this can be accomplished to a greater degree than is usually the case, it is the purpose of this article to indicate.

In any establishment of ordinary size, those concerned in the handling of an order from its receipt until shipment are:

Chief Order Clerk.
Works Manager.
Chief Stores Clerk.
Shipping Clerk.

Indirectly, the customer depends upon the shops for his shipment; but directly, he depends upon the shipper, who in turn cannot make shipment until the shops furnish him the finished product, the shops in their turn look to the stores department for the materials necessary to complete an order, and naturally nothing can be done until the order department has given the necessary orders for the work. At least, this should be the case; but there are places where verbal orders seem to receive as much consideration as written ones—a practice that is productive of no possible good. At any rate, the order department is looked to indirectly by all concerned in the manufacture of any article; so without further argument, we may assign to this department the important duty of keeping track of all orders from the time of their receipt until delivery is finally made to the customer.

If the four men heretofore mentioned are allowed to act as one body, with full power, the result is going to be better deliveries no

matter under what conditions the company may be operating. Organize a committee, composed of these four men; make them responsible for promises and deliveries—and you can depend upon it that they will exercise care before they set a time when an order will be shipped; for in their discussions, they will (or should) ascertain how much of an order is ready to ship, how much must be built, what is in stock ready to assemble, what is in stock ready to process, what must be purchased outside and about when this material can be secured, how long it will take the shops to process and assemble, etc.; and if track is kept of the progress the order is making, from time to time, there is every reason to expect that the shipment will go forward about when promised.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

OFFICE COPY

Buffalo, N. Y., June 23 1907.

Sold To	William Jenkins and Company	**Date Sold**	June 21 1907
Address	Utica, New York	**Sold By**	Johnson
Destination	" "	**Our Order #**	3445
Ship Via	Fast freight	**Their Order #**	A 25589

One cylinder head	X 442	3441
One cylinder	B 20	2811
One piston	X 440	3441

This is a rush order.

The Eng. Magazine

FORM I. INITIAL RECORD OF ORDER. MADE IN QUADRUPLICATE.

Let us take, for example, a plant manufacturing engines and boilers, and let us outline the arrangement that will enable the company to make more prompt deliveries. We will assume that the company has allowed a committee to be formed composed of the chief order clerk, works manager, chief stores clerk, and shipping clerk, the order clerk being responsible for the routine and clerical detail connected with the work. As the mails are opened and sorted, all orders are naturally turned over to the order department, and these orders can be written up; but before sending them to the various departments, they are referred to the committee before mentioned, to be acted upon

daily, along the lines just suggested. Four copies of each order should be made, one for the office (Form 1), one for the shipper, one for the works manager, and one to be sent to the customer as an acknowledgement of the order (Form 2). It will be noticed that Form 2 bears the possible date of shipment while it is checked at the top under the same date as shown by the clip. The copies for the works manager and the shipper should be marked in the same way by using the metal markers. Upon filing these orders in an alphabetical file, we have each order filed by name of customer and cross indexed by possible date of shipment; and as the three individuals most concerned have copies of the orders before them, it can be readily seen that it is possible for each and every one of the three to keep track of the progress of an order until the shipment is made.

ACKNOWLEDGMENT

	Buffalo, N.Y., June 23 1907.
Sold To William Jenkins and Company	**Date Sold** June 21 1907.
Address Utica, New York	**Sold By** Johnson
Destination " "	**Our Order #** 3445
Ship Via Fast freight	**Their Order #** A 25589

One cylinder head	X 442	3441
One cylinder	B 20	2811
One piston	X 440	3441

This is a rush order

We herewith acknowledge receipt of your order, which has been properly entered as above, for which accept our thanks. We will endeavor to make Shipment on or before

June 29 1907

THE ENTERPRISE COMPANY.

The Engineering Magazine

FORM 2. ACKNOWLEDGMENT OF ORDER.

In conjunction with this method of handling the orders, it would be well to use a recapitulation sheet, compiled each day by the order department, to be considered by the committee before mentioned at its daily conferences. A sample (Form 3) is here shown with entries. This will show the committee the total shipments promised for any one day, and by having each day's slip show the shipments arranged for the following day, it is an easy matter, in case it is absolutely impossible to make certain shipments as promised, to set new dates for shipment. It should be the duty of the order department to inform the customers of the changes; this will not only forestall com-

SHIPMENTS ARRANGED

For June 29 1907

According to our records, the following shipments have been arranged for the above date. If anything has occured in your department to change your plans, advise so a new date may be set and the customer notified of the change.

Name	Material	Fgt.	Exp.	Order #	Can we ship on above date			New Date
					Yes	No	If not, why	
Smith and Sons	Engine base			3421			Error in shop	7-10
Wm. Jenkins and Co.	Cylinder with head and piston			3445				
Jones and Co.	Complete Engine			2660				
Johnson and Frank	Boiler Fronts			3010				

THE ENTERPRISE COMPANY,
Order Department,
Per F. A. James

The Engineering Magazine

FORM 3. RECAPITULATION SHEET FOR SHIPMENTS ARRANGED.

plaints, but will create the impression in the minds of some customers, at least, that their interests have not been ignored altogether, for if you receive an *unsolicited* letter from a concern from whom you are purchasing, in which they state that they found it was going to be impossible to make the shipment as promised but that they would be able to on such and such a date, you certainly feel in a much better state of mind than if you should receive no notice of shipment and no letter explaining the reason.

After a shipment has been made, in cases where it is delayed, the manufacturer should keep after the railroad company until deliveries are shown. A "tracer" is such a common thing that it is not necessary to show one here, but Form 4 here shown should be used in conjunction with tracers so that the railroad company may be reminded of the fact that they have been asked to place a tracer after certain shipments. In many instances, upon receipt of these notices, the agent will take up the matter with those along the line and this will assist to a certain extent in bringing about better deliveries than would be

SHIPMENTS

July 5 1907

George Franklin, Agent

New York Central Railroad

To the agent.- Let us know at once if you have received any advice regarding the delivery of the shipments listed below

Date of tracer. June 20th

To. The Howard Manufacturing Company

500 Franklin Street

New York N. Y.

Date shipped. June 10th

Materials claimed short

Remarks. None of this shipment has been delivered and these people are in need of the material

THE ENTERPRISE COMPANY,

Per F. A. James

The Engineering Magazine

FORM 4. SUGGESTED FORM FOR TRACER.

secured were the railroad company to receive no such reminders. If the agent has received no advice he will say so, and if you take up this point with your customers, they will be quick to see that your interest did not cease when shipments were made—a decided point in your favor, and it is such points as this that the success of your business depends.

The system is simple, and while it would require a little work each day in order to obtain maximum results, does not the end in view justify the means? Let us sum up briefly the advantages to be derived through some such system, devised to meet your own conditions. In the first place your works manager, order clerk, stores clerk, and shipping clerk all know and have collectively agreed upon the dates of shipment, the points peculiar to each order having received attention before this was done; the orders are constantly before them, the metal markers showing the dates of shipments to be made; and through co-operation, which should be insisted upon, they will be able practically to see the end at the start.

The works manager will be in a position to plan his work to better advantage, for he can notify his foremen what he wants and when he wants it, they in their turn giving their men the necessary orders and instructions that will start the desired work along and through the shops in the most systematic way, so that in reality we have the whole force doing their share in an effort to get the work through on time.

The stock clerk will know what stock is necessary to get ready for the shops, and he will also know what has to be purchased outside. He can make the necessary requisitions on the purchasing department, with notations as to *when* he wants the materials that are to be ordered.

The purchasing department can keep after the people with whom the orders were placed, which in itself will have an influence in obtaining better deliveries; for once you know *what* you want and *when* you want it, you can in the majority of cases, by keeping after the concerns from whom you ordered, get your materials in time to enable you to keep your promise to your customers.

Your order clerk each day will bring to the attention of the others the list of shipments arranged for the following day, and if new dates have to be set, it can be done and he can so notify the people to whom the materials were going. At the same time he can take up with the others the possibility of getting future shipments off as promised, and by keeping track of the details and looking after the clerical work, he is in a position to give valuable information as to the status of any order.

The shipping clerk, knowing after each day's conference what is to go forward within the two or three days following, is in a position to see to getting everything in readiness for shipment on the day set; and if anything happens to make it necessary to change any date set, he knows it the day previous and can be governed accordingly. The shipping clerk is therefore in a position to make his work count for something, as he is able to concentrate his attention upon the accomplishment of something definite and is not forced to do a lot of work that will count for nothing.

In brief, we have a combination of brains working together along the same lines and with the same end in view, and this will accomplish more than could be accomplished by individual effort along widely different lines. The result of such effort would be more prompt deliveries and therefore more satisfied customers—the desire of every manufacturer.

NEW PROCESSES FOR METAL CUTTING AND AUTOGENOUS WELDING.

By J. B. Van Brussel.

Mr. Van Brussel's description is concerned chiefly with the characteristic elements of the processes so far available, and with the use of the oxygen blowpipe for metal cutting. This phase of the subject is extremely interesting, not only as affording new economies but as suggesting means for doing work heretofore almost impracticable. If, for example, the wreck of the Quebec bridge is to be removed, some adaptation of the blowpipe process (providing it is shown to meet the claims of its friends) would seem to provide the solution of an otherwise most difficult problem. The employment of the method for welding or brazing is further authoritatively presented in Mr. King's article elsewhere in this issue.—THE EDITORS.

SOLDERING metals by fusion—or autogenous soldering—though but a few years in use, is expanding rapidly in the most diverse industrial applications because of the advantages it possesses. Already it is rendering immense service, exceeding, indeed, the best that was hoped for it. Limited at the outset to the soldering of lead, it is now applied to almost all metals; and almost all industries, from heavy metal working to jewelry, find it a valuable and in many cases an indispensable auxiliary.

Practical autogenous soldering may be performed by means of *aluminothermie*, of electricity or of the blow-pipe.

Electricity furnishes often a practical and economical means for joining metals by fusion. Two modes of procedure are available. First, the electric arc may be made to act as an electric blow-pipe and so used. In this case the pieces to be joined are attached to the negative pole, and to their point of junction is presented a carbon attached to the positive pole. The heat of the arc causes local fusion of the metal. Disadvantages frequently met with are that the temperature is too high and difficult of control, and that the metal is burned. An alternative plan is to bring the two pieces which are to be joined into imperfect contact and to pass through them a heavy current (5,000 or 6,000 amperes for example) under a low tension. The resistance caused by the imperfect contact results in the heating and finally the fusion of the metal. It is readily understood that such an operation is not easy, but nevertheless excellent results are secured in special cases—for instance, in making chain links.

In the aluminothermic process the pieces to be joined are held in contact by any convenient device and the place which is to be brazed is surrounded by a clay mould. Above this is placed a crucible filled with a substance called by its inventor "thermite," which is a mixture of ferric oxide and powdered aluminium. By means of a special highly inflammable preparation the thermite is ignited and burns almost instantaneously, developing enormous heat. The temperature probably reaches 3,000 degrees C. The aluminium takes away oxygen from the iron oxide, the iron thus set free is melted, and flows into the mould between the pieces which are thus firmly brazed together. The process is particularly convenient for joining rails in place, for transmission shafting, and for the repair of broken parts.

The newest process for autogenous soldering, and without doubt the simplest and the most economical in practice, is that of the blow-pipe. In this operation the two parts which are to be joined are placed in contact and the operator directs upon the line of junction a blow-pipe flame capable of giving a temperature of at least 1,600 degrees C. Fusion of the metal takes place at the point where the flame strikes and the welding of the two parts is thus effected. The operator's skill when operating upon small pieces consists in stopping the action of the flame at the moment when fusion has proceeded so far that solidification is assured, and before it has advanced to a point where the piece might be destroyed or pierced. It is indispensable further that the flame of the blow-pipe should not be oxidizing but rather decidedly reducing.

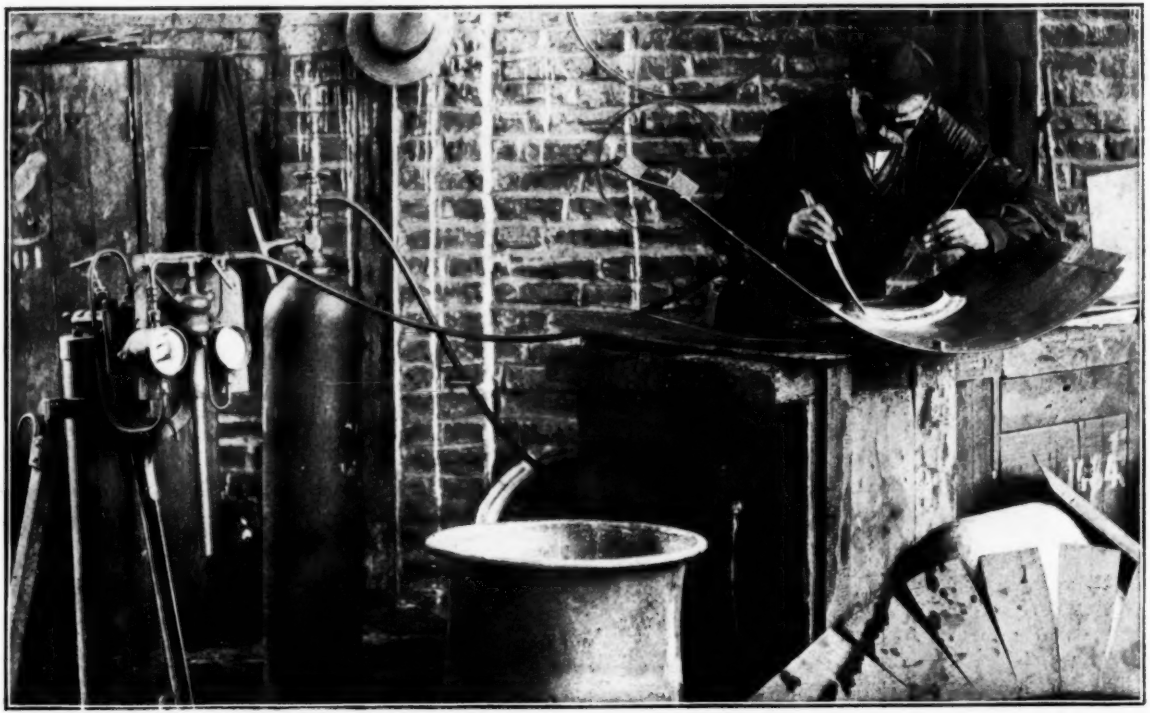
Blow-pipes may be classed according to the combustible material which they employ—hydrogen, acetylene, ordinary gas, and naphtha. All these utilize the same supporter of combustion, oxygen, which is usually supplied in flasks or tanks compressed to 150 atmospheres. It may be obtained by the electrolysis of water, by the distillation of liquid air, or by chemical reactions. The earlier forms of blow-pipe were operated with hydrogen obtained by electrolysis of water and stored in receptacles if prepared in advance, or in other cases generated at the point of use. Acetylene, employed in the second type, is obtained by the action of water upon calcium-carbide, and also may be generated in place or stored under pressure by taking advantage of its solution in acetone. It is not practicable to compress acetylene in reservoirs as may be done with hydrogen, because of its explosive qualities when compressed, which might cause serious accidents. MM. Claude and Hesse devised the acetone-solution method. The solution is stored in a flask filled with porous material, which forms a capillary tubular structure and prevents the spread of explosion.

OXY-HYDROGEN BLOW-PIPE IN OPERATION.

In this review we are concerned solely with technical considerations, and no attempt will be made to advocate any one method more than any other; in my opinion the most important factor in the successful conduct of the process, at the present stage of perfection attained in the various methods, is the skill of the manipulator.

The great advantage of blow-pipe brazing is that it is quite as applicable to mild steel as to iron, and that it permits the brazing of thin steel plates which hitherto must be riveted or clinched together, neither of these latter methods being satisfactory for producing a thoroughly tight joint. The blow-pipe is further most valuable for use wherever it is necessary to work upon parts already in place, as, for example, in joining pipes and tubes, steam conduits, etc. It comes into play particularly in the manufacture of metal tanks, various vessels made of enamel ware, feed-water heaters, etc., permitting the manufacture of forms of apparatus requiring numerous and complicated joints impossible to manufacture by forging. It has the further advantage of being a light apparatus, easily manipulated and requiring no elaborate installation.

At first sight it might appear that the melted or cast metal produced would not have the qualities of strength, and particularly of elasticity, shown by rolled or hammered material. Surprising results, however, are secured when care is taken during the process to avoid



BRAZING PLATES BY MEANS OF THE OXY-ACETYLENE BLOW-PIPE.

overheating or oxidation of the metal, or its alteration by the introduction of impurities such as sulphur or phosphorus. If, for example, we braze thin sheets or tubes of a few millimetres thickness and subject the brazed part to a light hammering or even a mild tempering, the metal will be found perfectly ductile and the joint will exhibit a strength almost equal to the resistance of the original metal. Tubes thus welded may be crushed or twisted, and plates may be bent and refolded, following the weld, without showing any cracks.

When it comes to the brazing of comparatively thick plates such as those of a boiler, the problem is more complicated because of the greater difficulty of producing uniform, thorough fusion to a thickness exceeding 6 or 8 millimetres. Under such conditions use is often made of an artifice which should be condemned, and which has to some extent discredited autogenous soldering of heavy plates. This artifice consists in chamfering both edges which are to be joined, and filling the space thus left by melting an iron wire in the blow-pipe flame. The procedure is not absolutely bad if it is very skilfully carried out, if the operator is careful to use a flame heating a large area and to let the drop of melted metal fall only on the part of the joint which has already been raised to the fusion temperature. It is easy to see what extreme attention is necessary to succeed in manipulation of this kind; if it is ill done, we get only poor adhesion; if it is well done, the relatively large quantity of melted metal introduced between the two edges lowers the strength and destroys the ductility. Test pieces submitted to tension break without elongation.

A process of autogenous soldering which is employed with much success and which is particularly applicable to plates from 6 to 25 millimetres thick is the following:

The two pieces to be joined are brought edge to edge without superposition, in perfect contact; if necessary to secure this they are first subjected to a light cut on the planer; they are then heated by means of two blow pipes, one above and one below, exactly opposite to one another, and producing as large a heated zone as possible. When fusion begins to appear on the surface it is safe to conclude that the interior of the sheet is at a white welding heat. The blow-pipes are then withdrawn and by a simple mechanical arrangement they are replaced by an anvil and a very light hammer not exceeding one or two kilogrammes weight. The blow of this hammer is sufficient to cause a consolidation of the metal along the two butting edges.

Perfect welding is secured and it is probable that the light hammering produces at the same time a certain orientation of the molecules favorable to the elastic properties of the metal. In fact, if

test pieces of metal so welded are tested under tension to the breaking point it is found that the grain of the fracture is not that characteristic of cast specimens, but is perfectly homogeneous, and like that of the original plate. The strength is but a small percentage less than the original and the elongation is satisfactory. Metal of a tensile strength of 36 to 38 kilogrammes and elongation of 25 to 28 per cent shows after welding a tensile strength of 36 kilogrammes and elongation of 13 per cent. These results are completely satisfactory for the majority of cases in which it is desirable to substitute for riveting a process of soldering, secured rapidly and by simple appliances requiring no complicated or costly installation.

In all ordinary forms of blow-pipe there is of course one tube supplying combustible gas and another supplying the agent of combustion. The differences consist principally in the arrangement of these tubes and especially in their mode of connection. All present forms make use, under conditions which we shall examine further, of a mixture of gases effected in advance.

SECTION OF FOUCHÉ ACETYLENE BLOW-PIPE.

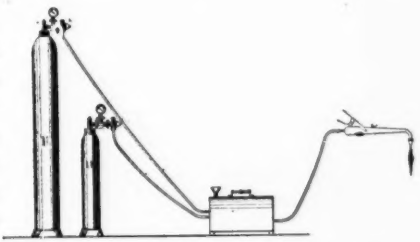
Acetylene Blow-pipe.

At first an ordinary form of blow-pipe was used for burning acetylene with oxygen. The two gases were kept separate up to the tip of the blow-pipe; that is to say, to the actual point of combustion. With acetylene, however, a serious inconvenience appeared; a heavy deposit of carbon took place, the flame was suppressed and indeed a sort of carbon mushroom resulted. It was therefore necessary to resort to some form of blow-pipe in which the mixture of gases might be made in the interior of the apparatus. But with acetylene a serious accident was to be feared, as the flame might flash back into the blow-pipe and cause an explosion. It is known, of course, that to prevent a back-draft of the flame the issuing gas must ordinarily have a velocity higher than that of the explosion wave, which for a mixture of oxygen and acetylene is extremely high. Practical experience showed that it was not necessary to attain this point because of the very small section of the blow-pipe tip. A velocity of flow equal to 150 metres a second is sufficient to prevent the flame from traveling back into the apparatus. In further prevention of this return of the flame the interior was filled with porous material, but this made it necessary to increase the pressure to the equivalent of 3 to 4 metres of water.

A problem still to be solved was that of utilizing acetylene not under pressure—that is, gas produced immediately in the works in calcium-carbide apparatus. M. Fouché found a very interesting solution by introducing the oxygen into the apparatus through an injector, which draws a flow of acetylene with it. The acetylene enters through extremely small tubes which do not permit the passage of flame.

Oxy-Hydrogen Blow-pipe.

In this apparatus the two gases are always used under pressure. The original form of hydrogen blow-pipe consists simply of a brazed sheet-steel receptacle terminating in a neck, upon which the blow-pipe tip is screwed. To the other end are brazed two attachments for the rubber tubing through which the gas flows from the reservoirs. Economy of combustion has been sought by preheating the gases. For this purpose they are made to pass through a coil surrounding the flame. This gives the regenerative blow-pipe. Lastly, in some important installations use has been made of a mixing blow-pipe. In this the blow-pipe itself is of the type already described, but it has a single attachment, for in this case the gases are mixed in advance.



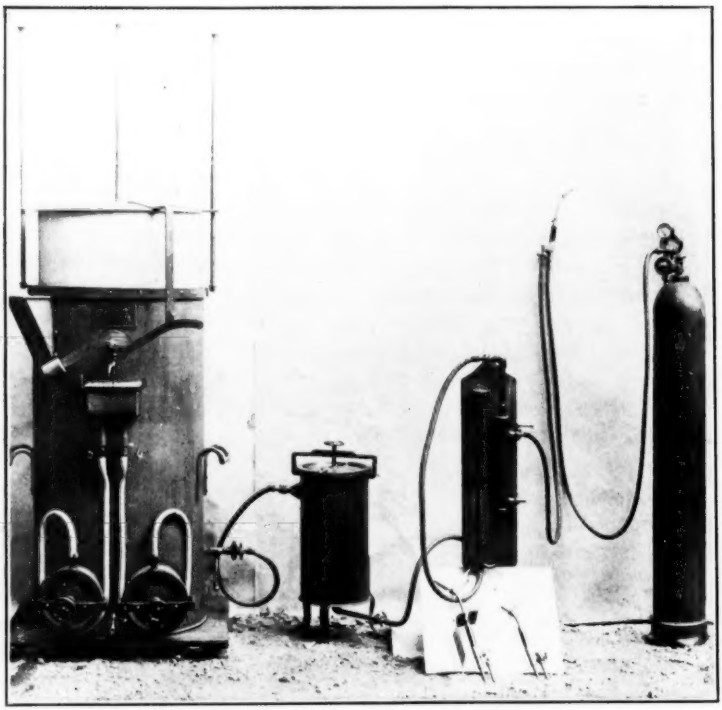
OXY-HYDROGEN BLOW-PIPE WITH MIXER.

It should be added that apparatus employing acetylene in solution and hydrogen in tanks is best suited for use in work requiring a portable installation and in establishments where continuous use of the process is not required; while it is more economical to use an installation with generators for acetylene and hydrogen where the work is to be continuous, or where the applications are many enough to allow continuous operation of the generating apparatus and are performed upon parts so light or so easily handled that they can readily be brought to the blow-pipe.

The Cutting of Metals.

We come now to the cutting of metals, or more exactly of iron and steel, by oxygen.

It is well-known that iron burns easily and rapidly in an atmosphere of oxygen gas. The experiment is familiar in every course in physics and chemistry. The same phenomenon occurs when a jet of oxygen is directed upon iron heated to a bright red—that is to

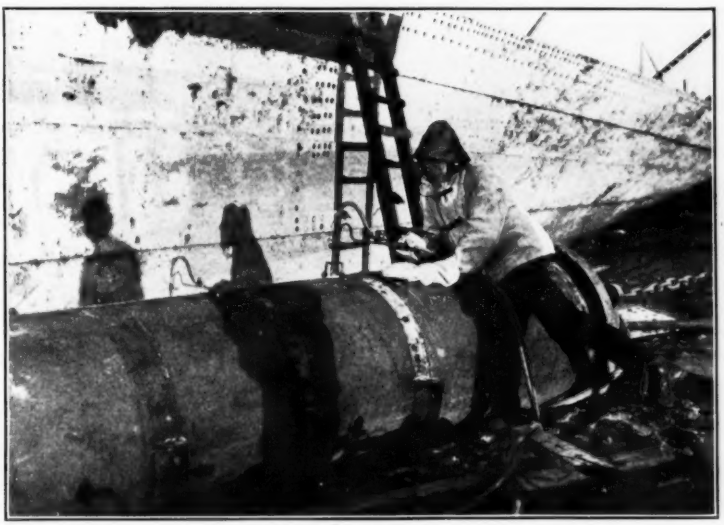


OXY-ACETYLENE BLOW-PIPE WITH ACETYLENE GENERATOR.

say, the metal burns and the heat evolved fuses the oxide. The process for cutting plates by oxygen is based on these phenomena; it can readily be seen that it is possible to divide a piece of metal by means of an oxygen jet, but it is not easy in practice to attain a regular and clean cut.

At first use was made of an oxy-hydrogen blow-pipe to bring a certain portion of the work to a bright red heat. Then the flow of hydrogen was cut off and the current of pure oxygen was increased. A good combustion was produced, but it did not proceed very long. The resultant iron oxide not being hot enough, lacked fluidity; it was with difficulty removed, became mixed with the partially melted iron, and thus obstructed the close contact of the metal with the oxygen; the combustion stopped and it was necessary to bring the blow-pipe into play again. The manipulator, even after long practice, could obtain only an irregular cut, dirty, and with edges incrusted with closely-adhering oxide.

One of the engineers of a company in Brussels therefore devised a double apparatus which entirely remedies these difficulties. This consists of two blow-pipes in one piece, which travel along the section to be cut. The first is an ordinary oxy-hydrogen blow-pipe which heats the metal to a bright red; the second directs a fine jet of pure oxygen upon the heated spot under a pressure varying with the thickness of the metal. The action of the two blow-pipes is continuous; the first prepares the way for the second, furnishing a volume of heat sufficient to permit instantaneous combination of the oxygen with the metal in the heated zone. The metal is not melted, and the adjoining parts remain unaltered, as the action proceeds too rapidly for the heat to spread into the mass and the oxidized portion is removed by the pressure of the oxygen; the section is cleaner than a saw-cut and its width never exceeds 4 millimetres. The speed of travel of the double blow-pipe is about 20 centimetres a minute; in other words, the operation is quite rapid and comparable to hot sawing.*



CUTTING A SHAFT BEARING LENGTHWISE.

The consumption of gas is relatively small, depending naturally upon the thickness of the piece which is to be cut. As the work is rapidly done the labor cost is not important.

* Interesting data of the use and cost of oxyhydric welding, etc., in locomotive work are given by Mr. King on pages 526-528 of this issue.

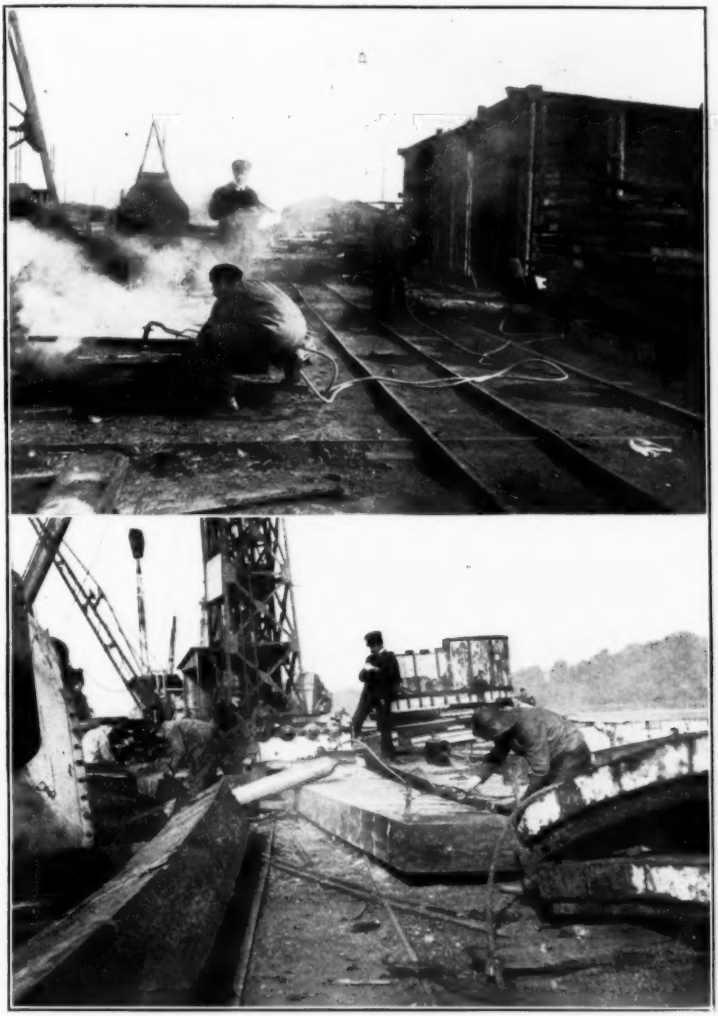
The double blow-pipe, which is easily handled and furthermore may be guided by any sort of mechanical device, is available for cutting not only thick plates, but also, and with equal ease, tubes, beams, shafts, and all sorts of rolled sections. The cutting may be made to follow any line, executing all sorts of curves and profiles; further, it is not necessarily normal to the surface, the cut being easily made on a bevel. It is evident further that the quality or the mechanical properties of the metal do not in any way modify the process; whether it be hard or soft, tempered or annealed, chrome or Harveyized, the steel burns just as fast. The problem of cutting armor plates is thus fully solved.

The essential qualities of the process may be thus summarized: Extreme simplicity of the installation and appliances, complete mobility, independence of any need of motive power, absence of any reaction upon the tool, extraordinary speed of operation, and so to speak unlimited adaptability.

In illustration of the rapidity which above all characterizes oxy-hydrogen cutting some examples may be adduced: An armor plate 160 millimetres (6.3 inches thick) was cut to a length of 1 metre in 10 minutes. A cut of similar length in a plate 15 millimetres thick took less than 5 minutes, and the cost of the operation did not exceed 1 franc 50 centimes.

To cut a manhole 300 by 400 millimetres (12 by 16 inches) in a plate 20 to 30 millimetres (.8 to 1.2 inches thick) requires 4 to 5 minutes. An opening 150 by 150 millimetres (6 by 6 inches) in a tube 5 millimetres thick required 3 to 4 minutes, while the cutting of the same opening with tools would need from 35 to 40 minutes. The cost of this work by the oxygen method was from 12 to 15 centimes.

Another very striking example was furnished at the station of the Metropolitan Railway at the Place d'Italie in Paris. It was necessary to cut away an iron staircase 6 metres high whose width impeded the traffic. It was cut down to a width of 1 metre in four hour's time. At Bremen, Germany, also, the method has been used for breaking up ships and among other records the following time data are interesting; a plate 300 millimetres (12 inches) thick was cut for a length of 1 metre to a depth of 4 to 6 centimetres in 7 minutes. The same plate had been cut with a pneumatic chisel along the length of 1.15 metres and to a depth of 1.5 centimetres, but this work had required an hour. The oxygen method was used also for rivet cutting; in less than 12 seconds the head of a 22-millimetre rivet could be burned without any injury to the plates. The rivet



ABOVE, STRAIGHT-LINE CUTTING OF 50-MILLIMETRE PLATES. BELOW, SLOTTING ARMOR PLATE TO A DEPTH OF 6 OR 7 CENTIMETRES.

was then driven out with a punch. The maximum thickness which has yet been cut is 210 millimetres (8.27 inches) in armor plate, but 300 millimetres has been reached in round shafting.

ABOVE, CUTTING OFF A MAIN SHAFT. BELOW, CUTTING A BEARING LENGTHWISE.

It has seemed of interest to examine the influence of this oxygen cutting upon mechanical properties of the metal. Naturally, there was fear that a certain zone of metal would be superheated and that it might even be oxidized to some depth. To determine these points

the double oxy-hydrogen and oxygen blow-pipe was used to cut a plate 15 millimetres thick, 500 millimetres long, and 250 millimetres wide. The practical tests were threefold; 1.—Micrography demonstrated that the material was a normal mild steel of about 0.15 per cent carbon. The examination of a metal section showed that there was no decarburization even on the extreme edge, and that at a very slight depth the pearlite showed the somewhat coarse structure of slightly overheated metal. Everywhere else the structure was strictly normal.

2.—Shock tests upon test pieces 10 by 10 by 60 millimetres notched to a depth of 2 millimetres, and taken at varying distances parallel and at right angles to the section made by the blow-pipe, gave the following results:

No. of Test.	Kilogrammes per square millimetre.	No. of Test.	Kilogrammes per square millimetre.
1	14	9	23
2	12	10	20
3	20	11	12
4	20	12	12
5	25	13	19
6	12	14	12
7	13	15	10
8	22	16	21

The concordance of these results is noticeable. In the average, it showed 20 kilogrammes lengthwise and 12 kilogrammes transverse, these results being very good. In order to examine particularly the part of the metal which showed an abnormal microscopic structure, this portion was cut into small test pieces so that by placing three of these side by side the equivalent of an ordinary test bar would be obtained. On this results of 18 kilogrammes longitudinally and 12 transversely were secured.

3.—Finally, on the plate, planed perpendicularly to the cut margin a series of Brinell tests were made with results which are closely concordant. Under a pressure of 3,000 kilogrammes the Brinell figures shown were:

On a first line 564, 555, 557, 563, 574, 576.

On a second line 542, 547, 557, 555, 558, 553.

From these various tests it may be concluded that the metal is not changed by oxygen cutting, at least so far as actual trial has yet demonstrated.

For convenience it may be recalled that kilogrammes per square millimetre multiplied by 1422.8 give pounds per square inch.

THE RAIL MAKER VERSUS THE RAIL CONSUMER.

By G. B. Waterhouse, Ph.D.

Mr. Coes' well written article on the above subject in the June issue of THE ENGINEERING MAGAZINE has once more brought to the front the very important rail question. The following short paper may be considered as a discussion of some of the points brought out in that article.—G. B. W.

NOTWITHSTANDING all that has been written and said about rails in the last few years, and particularly in the last year, it is questionable whether the full importance of the subject has been realized. Probably the best way to illustrate its vital interest would be to trace rapidly the upbuilding of the United States, and to point out how this is in great part due to the pioneer and helpful work of the railroads. It is recognized that the country was able to take, and did take, the advanced methods of transportation of older countries, and used them as a ground work in building up her own methods. These became the great factor in aiding the phenomenal national growth and expansion. Chief among these methods is railroad transportation, and the arguments given above are merely another way of saying that from the start the country is greatly indebted to the railroads. It would then be easy to show how railroad facilities and efficiency depend on good roadbed, and it is self-evident that the first requisite for this is a suitable rail.

So that, working backwards, good and suitable rails are not only essential, but amongst the foremost essentials for adequate railroad facilities, which in turn contribute to the very life of the country.

Mr. Coes mentioned in some detail the Talbot and duplex processes and it will be instructive to consider briefly the methods by which rail steel is made.

By far the greatest bulk is made by the acid Bessemer process which is so well-known that no description need be given. It must by no means be considered as a hit-and-miss process, as it is capable of very careful regulation—just as much so as the open-hearth process, if not more. The basic Bessemer process has attained great prominence, and produces a large part of the rail steel of Europe and Great Britain but none in the United States. It is similar in prin-

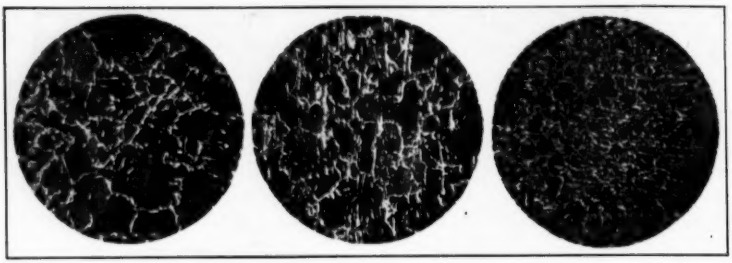
ciple to the acid Bessemer but in this case the lining of the vessel is basic, and is usually composed of calcined dolomite. The distinctive feature is that at the end of what would be the blow in acid practice, comes the afterblow. During this afterblow, phosphorus is oxidized and enters the basic slag, where it is retained.

In the basic open-hearth process a hearth is used, made of a basic refractory material, usually calcinated magnesite. A considerable amount of scrap can be used in the charge up to 60 per cent., and the phosphorus can be slagged off. The Talbot process is a modification of the basic open-hearth.

Most interesting of all is the duplex process, combining as it does the Bessemer and open-hearth. It was the dictum of a famous metallurgist that the latter would attend the funeral of the former process, but this has been very happily changed, as many indications point to there being a wedding instead of a funeral. In the duplex or combined process, the molten pig iron is first desiliconized, and partly decarburised, in an acid-lined converter. The partially blown metal is then transferred to a basic-lined open-hearth furnace, where the succeeding operations are carried on. When of the desired composition it is tapped out, and the necessary additions of ferro-alloys are made to the ladle. Made by whatever process, the steel is cast into ingots, which are subsequently rolled to the desired section.

Considerable attention is now being devoted to the production of good ingots. It is coming to be felt more than ever that many of the faults of the rails can be traced back to the ingot, and that unless it possesses the desired qualities to give good rails, no subsequent treatment can remedy its defects. The chief desideratum is soundness, which means steel as free as possible from blow holes, pipe, and mechanically held impurities. Very frequent reference has been made by recent writers to the difference in the metal in the various parts of the rail. Mr. Coes has brought out the reason for this very well, namely, the difference in the finishing temperature of the head and other parts of the rail. An examination was recently made as to the composition, strength, and structure of the material in various parts of a rail, some of the results of which may be given. The material chosen was from a 100-pound rail, made according to the specification of the American Society of Civil Engineers. The average composition was:

Carbon	0.51 per cent.
Silicon	0.147 " "
Manganese	0.77 " "
Sulphur	0.078 " "
Phosphorus	0.089 " "



HEAD. WEB. FLANGE.

The structure of the steel in the centre of the right half of the head, the centre of the web, and the centre of the right half of the flange is given in the accompanying micro-photographs which are magnified forty-seven diameters.

These are all transverse views, looking at the cross section of the rail. The constituents in each case are dark-etching pearlite, and yellowish-white ferrite. It is readily seen how profoundly the structure of the steel is influenced by the difference in the finishing temperature. The head, finished the hottest, has the greatest range of temperature to pass through before crystallization stops, and so gives the largest structure. The web is intermediate, and the flange is finished so near the recalescence point that the structure is very small. Tensile tests from the same places gave the following results:

Position.	Elastic Limit.	Ultimate Stress.	Elongation, Per cent. in 8 in.	Reduction of Area, Per cent.
Head	54,460	110,750	18.50	33.2
Web	53,100	110,300	18.25	29.4
Flange	53,340	111,300	17.00	36.4

The analysis from the head, web and flange were as follows:

Position.	Carbon.	Silicon.	Manganese.	Sulphur.	Phosphorus.
Head	.52	.152	.77	.079	.090
Web	.52	.150	.78	.077	.090
Flange ...	.52	.147	.77	.080	.090

From the analysis it may be seen how uniform the rail was in composition, and the results of the mechanical tests show that notwithstanding the difference in structure, the steel is also very uniform.

The flange shows itself to be unmistakably the best material, being slightly higher in tenacity and decidedly better in ductility than the metal in the web and head.

The above examination was made on a sample representing the heavy rails of the present day. The growth of the section from the smaller sizes of a few decades ago has been very marked and rapid. It is impossible in this paper to trace this growth, or its causes and

results, in detail. It is intimately bound up with the duties of the rail, a subject which is very complex and but little understood. No great and concerted efforts have been made by the rail consumers up to the present time, to investigate these duties. This means that the manufacturers have only been notified what quantity of material was required, and not particularly as to its quality.

The rail certainly has to perform three important functions. In the first place, it acts, as a whole, as a continuous girder, to support the passing trains, distribute the loads, and transfer them to the ties and ballast of the track. The second function is to resist the wear caused by the friction of the wheels and the loads, which occurs principally on the bearing surface. The third is to act as a guide to the passing trains. It would seem then that two of these principal functions are fulfilled by the head of the rail, and the chief property that is needed here is that of abrasive hardness, to resist the severe action on the side and upper surface.

Mr. Coes very early in his article brings out the fact that heavy rails do not give such good service as the lighter rails of earlier days. The metal apparently wears and flows more rapidly in the head than with the smaller sections. This is often, without thought, attributed to these newer rails being made of inferior metal.

The great increase in wheel loads, both of locomotives and trains, has been so repeatedly emphasized that it need only be mentioned here. Another reason why these larger rails apparently fail is that they absorb and carry in themselves a great portion of the wheel effects, which were previously transmitted to the ties and ballast. This has been emphasized many times by Dr. P. H. Dudley, the well known consulting engineer of the New York Central Lines. Especial reference may be made to his reports to the International Railway Congress, June 1904 and 1905, and to his paper "Rail Sections as Engineering Structures." The latter was read before the American Society for Testing Materials and published in Volume 5 of their Proceedings. He points out that the fact of the rails absorbing so much more of the load is the chief influence in the production of the smooth-running tracks we enjoy today. Without them it would be impossible to keep the roadbed in condition to handle the passenger trains, now common, of twelve or more coaches, travelling at a schedule of 55 to 60 miles an hour.

It must be evident that a transfer of a large part of the destructive work from the ties and ballast to the rail itself, cannot but result in the rail's having to sustain a greatly increased duty, and showing the effects of this heavy duty more plainly than the smaller rails.

THE COST OF STEAM POWER IN VARYING UNITS.

By Wm. O. Webber.

Mr. Webber's article is essentially a discussion of the power costs presented by Mr. Snow in our May issue. It carries the interest of a different point of view, and (we need not argue) an experienced and well-informed judgment.—THE EDITORS.

IN order to discuss fully the power-cost question on a fair and equitable basis, it is necessary, in the first place, that all items affecting the costs, in different instances, shall be fully weighed and taken into consideration.

For instance, an estimate upon a water-power development which considers simply the cost of the dam, head gates, canal, wheels, and, say, generators, does not and will not give a basis on which to determine the cost of the power. In every instance with which I am familiar, sums from $5 to $100,000 have been paid for flowage rights and the water "privilege." Now, the proportion that this sum bears to the total power developed is sometimes a very large one, and at other times, a comparatively small one; and the results are generally affected by the proximity of the location to an existing developed market. Otherwise it is impossible to reconcile the variations in the cost of larger water powers from $130 a horse power to $42, as all the difference could not arise in the construction alone.

In a similar manner the cost of steam power must be considered. The first cost of steam turbines and water-tube boilers is very much larger than that of horizontal engines and horizontal tubular boilers; but when the land and buildings required to house the two plants are taken into consideration, the differences in cost of original installation are very much reduced, and entirely change the aspect of the figures. There will be no question as to the advisability of the installation of the water-tube boiler and turbine plant in New York city or Chicago. It would be a very open question whether that should be the type of plant to be installed to operate, say, the Pacific mills, at Lawrence, Mass., or the Amoskeag mills, at Manchester, N. H.

The theory often advanced that the land and part of a building occupied by a small power need not be taken into consideration because the ground space and buildings are already available without

additional purchase, is fallacious; for the reason that, if they are not occupied by the power plant, they are available for an extension of the industrial plant and it is, of course, readily seen that the amount of room required for an individual electrical power-generating plant would be many times that of the room required for the motors necessary to drive the same machinery if current were purchased.

In fact, one of the great arguments that I know of in favor of a manufacturer purchasing an electric current outside, to drive individual motors in each room or department, is that he practically does not feel the loss of the small amount of room required for the motor, as it oftentimes is placed upon the wall or ceiling, where it really occupies no space available for other purposes, and the ability to draw from such sources at any hour during the twenty-four hours often makes the only real economic reasons for so obtaining power.

COST OF ONE STEAM HORSE POWER PER BRAKE HORSE POWER PER YEAR.
Simple Engines.

Size of plant in horse power.....	10	20	40	60	80
Cost of plant per horse power.....	$230.	$200.	$190.	$180.	$175.
Fixed charges at 14 per cent.....	32.20	28.	26.60	25.20	24.50
Coal per horse power per hour....	15.	12.	10.	9.	8.
Cost of coal @ $4.00 per ton.....	82.50	66.	55.	49.50	44.
Attendance 3,080 hours.....	50.	30.	20.	15.	13.
Oil, waste and supplies per year...	10.	6.	4.	3.	2.60
Total	174.70	130.	105.60	92.70	84.10
Without coal	92.20	64.	50.60	43.20	40.10
Coal @ $5.00.....	195.	146.50	119.35	105.07	95.10
" " 4.50.....	185.01	138.25	112.47	98.80	89.60
" " 4.00.....	174.70	130.00	105.60	92.70	84.10
" " 3.50.....	164.38	121.75	98.72	86.51	78.60
" " 3.00.....	154.06	113.50	91.85	80.32	73.10
" " 2.50.....	143.74	105.25	84.97	74.13	67.60
" " 2.00.....	133.42	97.00	78.10	67.95	62.10

ACTUAL COST OF ONE HORSE POWER PER YEAR IN SEVERAL PLANTS.

Average Horse Power.	Cost of Coal per Ton 2,240 Lb.	Total Cost per Annum.	Remarks.
182	$3.50	$57.59	No land or building cost.
133	3.25	60.00	" " cost.
100	3.50	65.60	" " or building cost.
97	4.45	86.80	All costs included.
75	2.90	92.40	No land or building cost.
50	4.75	111.05	" " " " "
20	4.45	133.50	All costs included.

I had recently to make a careful analysis of the relative costs of small powers in very small units, from steam, electricity, gas (both city and producer), and gasoline, and I was very much struck with the fact that, when all the items were taken into consideration, there was comparatively little difference in the costs, and still more struck

Cost of One Steam Horse Power per Brake Horse Power per Year.

Compound Condensing Engines.

Size of plant in horse power	100	200	300	400	500	600	700	800	900	1,000	1,500
Cost of plant per horse power	$170.00	$146.00	$126.00	$110.00	$96.00	$85.00	$76.00	$69.00	$64.00	$60.00	$58.00
Fixed charges at 14 per cent	23.80	20.40	17.65	15.40	13.45	11.90	10.65	9.65	8.95	8.40	8.12
Coal per horse power per hour	7.00	6.50	6.00	5.50	5.00	4.50	4.00	3.50	3.00	2.50	2.00
Cost of fuel @ $4.00 per ton	38.50	35.70	33.00	32.00	27.50	24.70	22.00	19.20	16.50	13.75	11.00
Attendance, 10-hour basis	12.00	10.00	8.60	7.25	6.20	5.40	4.70	4.15	3.75	3.50	3.25
Oil, waste and supplies	2.40	2.00	1.72	1.45	1.24	1.08	.94	.83	.75	.70	.65
Total	76.70	68.10	60.97	56.10	48.39	43.08	38.29	33.83	29.95	26.35	23.02
Coal @ $5.00 per ton	86.40	77.10	69.22	61.90	55.29	49.28	43.79	39.73	34.05	29.80	25.77
" " 4.50 " "	81.50	72.60	65.07	58.10	51.79	46.18	41.04	36.28	32.00	28.05	24.39
" " 4.00 " "	76.70	68.10	60.97	56.10	48.39	43.08	38.09	33.83	29.95	26.35	23.02
" " 3.50 " "	71.90	63.70	56.82	50.50	45.04	39.98	35.54	31.48	27.87	24.60	21.64
" " 3.00 " "	67.00	59.20	51.67	46.70	41.49	36.88	32.79	29.03	25.80	22.90	20.27
" " 2.50 " "	62.30	54.75	48.59	43.00	38.09	33.83	30.04	27.18	23.75	21.20	18.89
" " 2.00 " "	57.45	50.25	44.47	40.10	34.64	30.73	27.29	24.23	21.70	19.47	17.52

Cost of One Steam Horse Power per Brake Horse Power per Annum, 308 Days.

Triple Condensing Engines.

Size of plant	3,000		4,000		5,000		6,000	
Cost of plant per horse power	$54.00		$52.00		$50.00		$48.00	
Coal per horse-power hour	1.375 lb.		1.25 lb.		1.125 lb.		1.00 lb.	
Fixed charges @ 14 per cent	$7.56		$7.28		$7.00		$6.72	
Fuel @ $4.00 ton	10 h.	24 h.	10 h.	24 h.	10 h.	24 h.	10 h.	24 h.
Fuel @ $4.00 ton	$7.46	$14.92	$6.87	$13.75	$6.18	$12.37	$5.50	$11.00
Attendance, 10-hour basis	2.75	5.50	2.50	5.00	2.25	4.50	2.00	4.00
Oil, waste and supplies	.50	1.20	.40	.96	.35	.84	.30	.72
Total, coal, @ $4.00	18.27	29.18	17.06	26.99	15.79	24.72	14.52	22.44
" " " 3.00	16.40	25.45	15.40	23.56	14.24	21.90	13.14	19.69
" " " 2.50	15.47	23.59	14.38	21.84	13.47	20.22	12.46	18.32
" " " 2.00	14.54	21.72	13.76	20.12	12.69	18.53	11.77	16.94

COST OF INSTALLATION OF A 10 HORSE-POWER STEAM PLANT.

Land for engine and boiler room, 300 sq. ft. @ $1	$300.00	
Boiler and engine-room building, 300 sq. ft. @ $1.50	450.00	
Chimney, 18 in. by 40 ft.	400.00	$1,150.00
10 horse-power boiler	$241.00	
Boiler foundation and setting, 3,900 C. B., 500 F. B.	160.00	
Blow-off tank	31.00	
Damper and regulator	75.00	
Injector tank	10.00	
Water meter	40.00	
Piping for same	20.00	
Pump and vacuum	122.00	
Feed-water heater	40.00	
Pipe covering	50.00	789.00
Engine, 7 by 10	$184.00	
Foundation for same	60.00	
Steam separator	35.00	
Oil separator	25.00	
Piping	95.00	
Freight and cartage	30.00	429.00
		$2,368.00

COST OF INSTALLATION OF A 60 HORSE-POWER STEAM PLANT.

Land for engine and boiler room		$2,500.00
Buildings for engine and boiler room		2,500.00
Chimney		1,200.00
80 horse-power boiler	$790.00	
Ash pan for boiler (below high tide level)	120.00	
Boiler and engine settings	1,282.00	
Blow-off tank	31.00	
Damper regulator	75.00	
Injector tank	10.00	
Water meter	60.00	
Piping for same	22.13	
Pump and receiver	146.50	
Feed-water heater	70.40	
Pipe covering	70.75	2,677.78
Engine, 12 by 30	$1,065.00	
Pan for engine fly-wheel	72.00	
Steam separator	60.00	
Oil separator	41.80	
Piping, freight and cartage	1,026.41	2,265.27
Shafting in place	$550.00	
Belting in place	285.00	835.00
		$11,977.99

$11,977.99 ÷ 60 = $199.63.

with the fact that in the explosion engines the cost per horse-power hour, while of course varying with the size of the unit, kept proportionally the same when developed part of the time or full time, on the same unit, whereas in the steam engines this was not so.

Another feature of the costs of small powers is almost universally forgotten. For instance, it having been generally advertised that a gasoline engine would produce a horse power on ⅛ gallon per hour, it is generally assumed that this will always be so no matter whether any given engine is being worked up to 100 per cent load factor or on a 25 per cent load factor. As a matter of fact, it will be found that almost any gasoline engine, of the single-cylinder type, which will operate on ⅛ gallon at 100 per cent load factor will require over a gallon per horse power at a 10 per cent load factor; and a small steam engine which would run on 5 pounds coal per horse power per hour, at full load, would be using 15 pounds of coal per horse power per hour at one-quarter load. This is fully recognized by the big electrical-service companies, who make big reductions in their power charges as the power consumed in any one month increases.

The industrial world is beginning to recognize that the actual cost of power is growing to be a very important item which is going to increase steadily in importance as our natural resources, such as coal, oil, natural gas, and water power decrease, and methods will have to be devised to produce the maximum of result for the minimum of expenditure, in order to keep the power problem within due bounds as an item of productive costs.

To comment further on the figures given by Mr. W. E. Snow in THE ENGINEERING MAGAZINE for May, 1908, we seem to agree quite closely at the two ends of the line regarding costs of plant per horse power, my figure for 10 horse power being $230, Mr. Snow's being $220, and, at 2,000 horse power, my figure being $56, and Mr. Snow's being $53.20. Where we vary most is from 40 to 100 horse power, my figure for 40 being $190, Mr. Snow's figure being $110, my figure for 100 being $170, Mr. Snow's figure $106.

I should also criticise his boiler costs, including setting, and should say that his figures would just about furnish the boilers without the setting. I am afraid, also, that in the coal consumption per horse-power per hour he has taken only the coal consumed during running hours, and has allowed nothing for banking and keeping up steam in cold winter nights, all of which must be taken into account.

I should also criticise his attendance items. My experience has been that the average cost of attendance is fully 50 per cent higher than Mr. Snow allows for.

With these exceptions, and the neglect to take into account the item of ground rent, I think Mr. Snow has contributed some exceedingly valuable data, and I wish we could obtain similar data on gas-producer and other forms of power.

PATENT-OFFICE CONTESTS BETWEEN RIVAL CLAIMANTS TO AN INVENTION.

By Edwin J. Prindle, of the New York Bar.

This article is supplementary to Mr. Prindle's study of Patents in Manufacturing which we published some months ago. We shall shortly issue the entire series in book form, and the manual will be of the utmost value to all in any way connected with the development, use, manufacture, or sale of patented articles or devices.—THE EDITORS.

WHEN an inventor gets into the Patent Office and finds another is claiming the right to a patent for the same invention, it usually develops that his own right to prevail over the other claimant depends upon the history of the invention before the application was filed, and his success or failure in the contest will frequently depend on acts or omissions in that history which were entirely within his control, and on his ability to prove those acts which were essential. Usually, too, all this history is made before the invention is ready to patent, and therefore before it is brought to the attention of counsel, so that the acts and the laying of the foundation for their proof depend entirely upon the unadvised judgment of the inventor, or those owning the invention. It is therefore of importance that those having to do with inventions should have sufficient knowledge of the general principles upon which such contests are decided to arrange those things which are in their control so as to give them the best possible chance of a favorable decision.

The production of an invention begins with a mental conception and ends with a reduction to practice. The conception of an invention does not consist in perceiving the mere desirability of accomplishing a certain object, but it consists of a complete working idea of at least the principal elements of some means for accomplishing that object, and of the correlation of those elements. This difference between a perception of the desirability of accomplishing a certain object, and the conception of the invention, might be illustrated in this way. Many people before Bell had thought of the desirability of being able to talk at a distance by means of electricity. This, however, did not benefit the public in any way. The public was no more able to talk at a distance than it had been before. Bell, however, thought out in his own mind how a telephone should be constructed which would transmit speech at a distance by means of electricity. This conception of Bell's would, if put into practice, give the public practical

possession of the invention. When a telephone had actually been constructed according to Bell's conception and used, the invention was what is known as "reduced to practice." The conception alone does not make an inventive act. A man might fully conceive how to make a valuable machine, but if he never puts that conception into practice, he has done the public little or no service, and the law does not regard him as an inventor. To illustrate further: Suppose a person perceived the desirability of making chain from a wire rod by an automatic machine. This would not in any sense be a conception of an invention within the meaning of the law. But suppose he clearly thought out the shape of the parts which were to cut off the blank from the rod and bend the blank into a link, and to thread the next blank through the link and bend it into a link, so that he knew exactly the shape and relative motions and times of operation of the several parts which would operate directly upon the blank and link. If the conception was so fully worked out that any mechanic of ordinary skill could supply what was missing in the way of gearing for operating some of these parts, the conception would be considered complete even though such parts had not been worked out. The invention would, however, be reduced to practice only when a machine had actually been constructed.

FIG. I. DIAGRAM OF THE PRODUCTION OF AN INVENTION.

The theory of the law is that the production of an invention is a single act, beginning with the conception and ending with the reduction to practice, and the law awards the patent to that inventor who first conceived the invention, whether or not he was the first to reduce the invention to practice, so long as the time between his conception and reduction to practice was occupied by reasonably diligent efforts to reduce the invention to practice. This act may cover a considerable period. Many months may elapse between the conception of the invention and its reduction to practice provided the inventor is reasonably diligent in his efforts to reduce the invention to practice, or, at the time of the advent of his rival, was exercising reasonable diligence. Thus a complete inventive act consists of a complete conception of the invention followed by a reduction of the invention to practice, the conception being coupled to the reduction to practice by reasonable diligence. The inventive act might be illustrated by the diagram in Figure 1, in which the first vertical line represents the conception, the horizontal line represents the diligence, and the second vertical line represents the reduction to practice.

Conception of the Invention.

While the nature of the conception of an invention has been pretty fully indicated before, some further discussion of it may be desirable. The conception of the invention must originate in the mind of the inventor. He cannot be entitled to a patent if he obtains knowledge of the invention in any other way than by generating the idea in his own mind. It may come in a flash, or it may be the result of months or years of experiment and thought. It may be suggested to the inventor by something not the invention. For instance, a father happened to see his little son nailing together some sticks. The boy had nothing more in mind than to drive nails into the sticks and fasten the sticks together, but as it happened there were four sticks fastened together by four nails in a peculiar way. The child having driven the nails picked up the sticks, and as he lifted them, they swung on the nails, as on pivots. The sticks had a peculiar motion, and this motion suggested to the father a mechanical movement which he invented and applied to two different purposes and patented. Obviously, the invention never existed in the sticks. The child would have thrown them away or knocked them to pieces, and the invention would never have come into existence, if it had not been for the operation of the mind of the father on the nebulous idea contained in the sticks accidentally fastened together in a peculiar way. Thus the invention was the result of the suggestion, and yet it was a real invention supporting a valid patent.

The reverse of the mechanical-movement incident was a case of the invention of a metal bar for reinforcing concrete, which bar was provided with a large number of indentations, or corrugations on its surface to give it a strong hold on the concrete, and yet the corrugations on opposite sides were so arranged that the cross section of the bar was substantially uniform throughout its length, and thus its strength was not impaired. One of the claimants for the patent, J——, showed that he had made bars which had corrugations or indentations on opposite sides, and these corrugations were so shallow that the cross section happened to be fairly uniform throughout the length of the bar. The corrugations, however, were not accurately staggered with reference to each other on opposite sides of the bar, and he was unable to show that at the time the bar was made he had any realization of the advantage of accurately staggering the corrugations so as to make a bar which, while roughened, would be substantially uniform in cross section. It was held that he had no conception of the invention at the time he made the bar. J—— did not realize the importance of making the corrugations staggered and the

next bars he should make were just as likely to have the corrugations in line with each other (in which relation they would weaken the bar) as staggered, and it was only when something later showed him the advantage of staggering the corrugations that he appreciated the invention.

As it would obviously be inequitable to permit an inventor to establish the date of his conception of an invention by his own unsupported testimony, it is required by the Patent Office and the courts that his testimony be corroborated in some manner. The temptation to put the date farther back than it really was is strong, and the settled principle has been adopted that no earlier date will be awarded an inventor than the earliest date when he can show some corroborative evidence. This evidence would usually be the evidence of some person to whom he described the invention at the date in question, or some writing. The person to whom the invention was said to have been disclosed must be able not only to fix the date but to testify that a complete disclosure of the proposed structure of the invention was made to him. It will not usually be sufficient for him to allege merely that the invention was disclosed to him at a certain date, unless he can establish the correctness of the date by reference to some event which was of sufficient importance or peculiarity so that he was not likely to have been mistaken as to the date of the event, or by reference to some memorandum which he made concerning the invention at the date in question. The corroborating witness will not sufficiently corroborate if he simply testifies that the inventor gave him at that time a complete description of how the invention was to be constructed, but he will have to be able to testify as to the details of that construction—at least sufficient details so that his description answers to the requirements of a conception of the invention. He will at least have to be able to testify as to the main features of the invention.

F. had no corroboration of his conception of the invention except statements in a memorandum note-book which he had written. He was able to produce a witness who testified that F. had such a book at a given date, but, as the witness had not seen the entry, it was held that the date was not established.

In the case of joint inventors the single conception must be the product of the two minds in order to be a joint invention. In other words, it is not sufficient that one inventor conceived of certain parts of the invention and the other inventor conceived of other and unrelated parts of the invention, to make a joint invention, but the conceptions of the two minds must be so interwoven as to make together

a unitary invention. For instance, if one man invented a new construction of the runner of a centrifugal pump by which a higher efficiency was obtained, and another inventor improved the bearing of the shaft of the pump, this would not be a case of joint invention, because it is obvious it would be immaterial to the more efficient action of the runner what kind of a bearing was used, so long as the friction was reduced to the same degree; and it would, on the other hand, be immaterial to the action of the bearing what sort of an object was carried by the shaft.

An application for letters patent filed in the Patent Office is of course evidence of conception of the invention at the date of filing. Since an inventor's right to a patent may turn wholly on his ability to establish the date when he first conceived of the invention, it is desirable that each step in the progress of the conception be recorded in some way. The inventor should preferably make a careful description or drawing, or both, of the idea as it first occurs to him, and should fully explain it to some person capable of thoroughly understanding it, and should sign the description and drawing himself and write the date upon it himself, and should ask the person to whom he has explained it also to sign the description and drawing. It would also be desirable that the witness should write the date in his own handwriting, so that there could never be any question as to the correctness of the date when the signatures were placed upon it. It is also very desirable that there should be no changes made in the description or drawing after it is signed. As each additional step is worked out, if the invention is worked out step by step, the new step should be shown in a new description and drawing, carefully witnessed as was the first one.

Caveats.

When the inventor has a theoretically complete idea as to how an invention may be carried out, but it is evident that before the invention will be of practical value he must spend a considerable amount of time in further work and experiment, the law provides that he may file in the Patent Office a description of the invention as far as he has gone, in the form of a caveat. This caveat is notice to the Patent Office that the inventor is working on the invention, and it entitles him to notice if any other inventor files an application for patent for the same invention or an invention involving the same principles. When the application is filed in the Patent Office, the Patent Office will suspend action on the application and notify the caveator and give him a limited time in which to complete the invention and contest with the applicant the right to the patent. Where an invention is complete,

there is no advantage in filing a caveat, and there is in fact a disadvantage, because a caveat is never regarded as equivalent to a reduction to practice, while the filing of an allowable application is so regarded as will later appear. The inventor, when his invention is complete, should file an application for patent, not a caveat.

Reduction of the Invention to Practice.

Actual experience shows that many ideas may be described in words, or even most carefully worked out in drawings, but yet do not operate successfully, when actually tried. Therefore the law requires that an inventor shall actually reduce the invention to practice by building and testing the physical thing (with certain exceptions mentioned later) before the invention will be considered complete. This reduction to practice is, as above stated, the final step in the inventive act. The inventive act consists of a mental part, the conception, and a physical part, the reduction to practice. The safest and most complete reduction to practice is the actual building and using of the device. There are some devices so simple that it is certain from a mere inspection of them that they will successfully perform their intended function, and in these cases no test is required, but only the actual construction of the device. For instance, in a contest between two inventors over an envelope, one of them showed that he had made the envelope at a certain date but had never actually put it into commercial use. It was held that a mere inspection of the envelope was sufficient to show beyond question that it would perform its intended function, and so the mere construction of the envelope was a complete reduction to practice.

It is, however, dangerous for an inventor to stop short of actual use of the device, because it is frequently a matter of opinion whether or not actual use was necessary to demonstrate the practicability of the invention. Some very simple inventions have been held not to have been reduced to practice where the invention was constructed but not actually used. For instance, in the case of a roller bearing, the inventor who first constructed his bearing was held not to be entitled to the patent as against a later inventor, because he had not actually used the bearing. Even so simple a device as a garment hook was held to have required use to complete the reduction to practice.

An inventor must be careful not to let his conduct after an actual reduction to practice be such that it will discredit the reduction to practice. If he treats the machine which he built and used in such a way as to raise the inference that he does not regard the machine as a success, he may destroy his right to a patent. For instance, a stamp-cancelling machine was completed and operated in cancelling stamps

in a post-office at Boston several hours a day for several days. This would ordinarily be a satisfactory reduction to practice, and, if the inventor had immediately filed his application for patent, he would have prevailed as against a later inventor of the same machine. The inventor of the Boston machine, however, took the machine back to the shop and partly dismantled it and then laid it aside and never again operated it or tested it in public. A second inventor made the same invention and applied for a patent, and afterwards the first inventor applied for a patent. It was held that the first inventor's conduct raised the presumption that the use of the machine in the Boston post-office was a mere abandoned experiment instead of a successful reduction to practice, and that the second inventor was the one entitled to a patent. The mere fact that a second and better machine on the same principle was made after the first machine would not discredit the first machine, but the first machine would be held to show diligence in reducing the invention to practice. The device which is claimed as a reduction to practice must be sufficiently perfect to demonstrate the practicability of the invention. It must operate successfully; but if it goes that far, it does not destroy its value as a reduction to practice to show that the machine was crudely constructed. The mere accidental production of an invention without appreciation of what has been done is not a reduction to practice of the invention. A mere model, which, although complete in its form, and illustrating how a real machine would be constructed, but which model was itself incapable of successful operation, is not a successful reduction to practice. A device, however, which, although intended as a model, is capable of and does actually successfully perform the intended function, is a reduction to practice even though the inventor intended to use better and different materials in the commercial manufacture of the machine, and this although the model may be only half the size of the commercial machine.

As I have indicated, there are some exceptions to the requirement than an invention be actually and physically reduced to practice. In the case of the Bell telephone patent, Bell's application for patent was in a contest with other inventors, and the evidence did not show that Bell ever actually made a telephone transmit speech before the filing of his application for patent; but as his application for patent fully described how such a telephone should be built, and as the experts of the Patent Office had decided that a telephone built as described in the application would work, and as telephones so built had worked, the Supreme Court of the United States held that the filing of this

allowable application for patent raised a presumption that he had actually and physically reduced the invention to practice, and that therefore the filing of the application was a "constructive reduction to practice" and counted for him the same as if he had actually constructed and operated such a telephone at the date of the filing of his application. Thus, when an inventor has filed an application for patent which is held by the patent office to be allowable, he has done what is legally the same thing as building and testing his invention. This is very valuable, as it frequently and usually costs much less to file an application for patent than to build and test the invention. It some times happens, however, that an opponent in the contest is able to show that the invention, if constructed as described in the application for patent, would not operate successfully, and if it would require more than the skill expected of the ordinary good mechanic to correct the defect, the application loses its value as a reduction to practice. It is, therefore, important, when possible actually to reduce the invention to practice.

Diligence.

If no rival claimant enters the field, an inventor may take as long as he pleases in reducing his invention to practice, provided the public does not get a knowledge of the invention in some other way and put it into use. If, however, a rival enters the field, the first conceiver must be exercising reasonable diligence, or the second conceiver will be held to have the superior equities and be entitled to the patent. This qualification that the diligence must be "reasonable" is interpreted in each case in the light of its circumstances. For instance, it would be an insufficient excuse to say that an inventor did not have money to reduce the invention to practice, if he was at the same time spending money in other inventions; or to say that he did not have money to apply for a patent, if at the same time he were applying for patents on other inventions. It would not be sufficient to say that he was delayed by illness, if the illness only covered a part of the time. The excuse must cover the whole time with which he is chargeable. Temporary insanity or great poverty or serious illness would be a sufficient excuse. The mere making of drawings is not a sufficient excuse, if that is not promptly followed by actual construction. Evidently, the safest plan is to proceed with all reasonable speed actually to reduce the invention to practice. The steps connected with the reduction to practice and testing of the machine or other invention should be recorded in the way indicated in connection with the conception of the invention.

INTERFERENCES, OR CONTESTS BETWEEN RIVAL CLAIMANTS.

We will now consider how the Patent Office decides some typical cases of contests or "interferences" between rival claimants.

The most important principle is, that the first to conceive the invention is entitled to the patent if he couples his conception with a reduction to practice by reasonable diligence. Another important principle is that the first inventor to file an application for patent is presumed to be the first inventor in fact, and the burden of proving that he is not the first inventor lies on the inventor who comes later into the Patent Office. This second principle shows the importance of getting promptly into the patent office.

Before the Patent Office lets either partly know who his opponent is, it requires each party to file, under oath, what is known as a "preliminary statement." In this the inventor is required to state: (1), the date of the original conception of the invention; (2), the date upon which a drawing was first made; (3), the date upon which the invention was first disclosed to others; (4), the date of the reduction to practice of the invention; and (5), a statement showing the extent of use of the invention. The inventor will not ordinarily be given the benefit of proof of any earlier dates than those set up in his preliminary statement, because of the strong temptation to change the dates after he has seen his opponent's dates.

FIG. 2.

Taking now a few typical cases.

A (first) conceived and (second) reduced to practice; and B (third) conceived and (fourth) reduced to practice. Here A's invention was complete before B's entered the field, and the interval between A's conception and his reduction to practice is unimportant, however great, and he is entitled to the patent. See Figure 2.

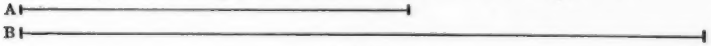


FIG. 3.

A and B conceived simultaneously, but A reduced to practice before B. Obviously A is here entitled to the patent. See Figure 3.

A (first) conceived and (second) reduced to practice, and then concealed the invention for a long time, waiting for commercial developments that would justify his putting the invention on the market. B (third) conceived the invention; A (fourth) filed an application for patent, and B (fifth) reduced the invention to practice, having been diligent from his conception to his reduction. A's concealment of the invention puts his original reduction to practice in the category of an

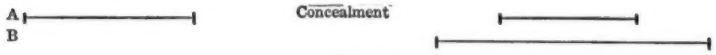


FIG. 4.

abandoned experiment, since the law does not favor such concealment; and thus A's filing of his application for patent is held to be his date of conception and also his date of constructive reduction to practice. Although B did not reduce to practice until after A's application, he is entitled to the patent, because he conceived the invention before A filed his application for patent, (and therefore before A's legal date of conception) and coupled his conception with his reduction by reasonable diligence. This case is illustrated in Figure 4.

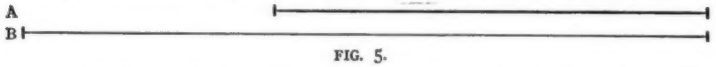


FIG. 5.

A and B simultaneously reduced the invention to practice. Obviously the equities as to the reduction to practice are equal here, and he who first conceived the invention would be entitled to the patent, provided he was reasonably diligent when the second one entered the field. This case is illustrated in Figure 5.

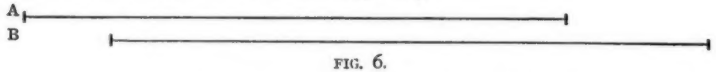


FIG. 6.

A (first) conceived the invention; B (second) conceived the invention; A (third) reduced the invention to practice, and B (fourth) reduced the invention to practice. Here B's conception took place before A's reduction to practice, but as A began the inventive act before B and carried it through to completion with reasonable diligence, he is entitled to the patent. This case is illustrated in Figure 6.

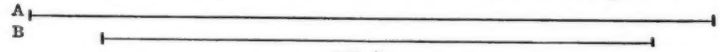


FIG. 7.

A (first) conceived the invention; B (second) conceived the invention; B (third) reduced the invention to practice, and A (fourth) reduced the invention to practice. Assuming that both inventors were reasonably diligent, A would be entitled to the patent, because he who first begins the inventive act is always entitled to the patent, if he carries it through diligently.

This article is not intended in any sense to be a complete statement of the law of interferences, but is only intended to show what precautions it is necessary to observe in the production of an invention and in making records of the various steps, and to show the importance of promptness and thoroughness, because these must be attended to, if at all, before the invention is brought into the Patent Office.

MODERN IDEALS IN MECHANICAL-ENGINEERING EDUCATION.

By Walter Rautenstrauch.

Professor Rautenstrauch's article is more than a critical review of foregoing proposals for engineering education. It is a strong piece of constructive work, vigorously supported by justification of its ideals and demonstration of its methods. We are glad indeed to be the medium for presenting so able a contribution to the topic just now engrossing the attention of two great technical societies.—THE EDITORS.

VISITS of European engineers to American engineering schools and shops; visits of American engineers to European establishments; the creation of committees and commissions for the study of industrial conditions, with a view to the establishment of appropriate educational systems; the establishment of special apprentice courses in large works, and the ever-present and rapidly increasing public and private conferences between the officials of our schools and practicing engineers—all indicate an awakening to the national importance of a proper system of industrial education. But the diversity of opinion and the differences between the courses of instruction indicate that there is yet no agreement and that the subject requires continued study.

With but few exceptions, the growth of the greater industries in this commercial age (which is essentially an age of machinery) has been coincident with the development and application of machinery, without which they could not exist. As in the early days the machinist who constructed machines developed into the machine designer and machine operator, so in later days this type of man through scientific education developed into the mechanical engineer, who through his study of the forces in machines and their applications involved in production and applied to specific needs, proved to be the best qualified to study the forces controlling the men who must make and use these machines in the great industrial organizations. Mechanical engineering has thus become that profession which is concerned with machinery and men, and its practice includes the design, construction, performance, and use of machinery in the generation of power; the manufacture of the articles of commerce; and the management of labor and of the economic conditions which affect the

output and marketing of the products of the factory. It is a fact, therefore, that a knowledge of mechanical engineering is the only foundation on which can be built a system of industrial education. Its function is to furnish the officers and administrators, while the ranks and file must be recruited through the trade-schools and the shop itself. A careful consideration of the above requirements should determine the subject matter of a course of instruction in mechanical engineering, together with the educational methods required for professional preparation.

That these conditions have not been met in many of the older courses of study in our engineering schools to be due to a species of mental inertia. The establishment of the principles of thermodynamics by Clausius and Hirn seemed to offer means for analyzing the performance of heat engines and for producing more efficient machines. At the same time the development of the theory of elasticity by Fairbairn and Unwin seemed to offer means for correctly proportioning parts of machinery for strength. These two mathematical theories, together with the then well-known laws of hydraulics, analytical mechanics, chemistry, characteristics of materials, and the necessary mathematics for the proper understanding of the subjects, all seemed to require (because of their inherent difficulties, and the small number of men who understood them) the establishment of courses of study for their proper teaching. Thus the courses in mechanical engineering which have characterized American schools grew up, and consisted very largely in a consideration of these subjects, on the assumption that their study was a proper preparation for the practice of mechanical engineering.

It is difficult for those men who have spent their lives with this idea, even though its limitations have been prominently brought out by years of experience, to change or to admit the necessity for a modification to meet the actual demand. There has been a gradual separation of the work of the schools from the practice of the profession, indicated by the frequently heard distinction between "practical" and "theoretical." This distinction would not have to be made, nor would the apprentice courses in large industrial works have had to be established, had the graduates of our technical schools been able to fit into the scheme of professional practice. Thermodynamics contributes very little to the actual building of steam engines, for while it pretends to give all the conditions for economy of operation and their proper relation, yet it is impossible today to calculate or to predict the steam consumption of an engine or the performance of a

boiler. In spite of the great development of thermodynamics in recent years, the economy of steam plants can be fixed only by test; it is not a subject of prediction through the laws of thermodynamics, but rather a subject of judgment based on practical experience as much as if not more than on formulated thermal relations. The test, therefore, remains the criterion, although mathematical thermodynamics may point the way and prevent the attempting of much that is certainly impossible. Furthermore, the design of the structural parts entering into the engine can be calculated only by making assumptions of the working conditions, and their actual construction depends on the correction of the mathematical theory of elasticity, however implied, by a study of breakages which would not have ever occurred were the theory complete. Not only do the mathematical theories of thermodynamics and elasticity fail to provide what is necessary for the prediction of results in the complete machine, and therefore, fail to provide a complete theory for the design of that machine, but both have absolutely ignored the conditions which prompt its construction—that is, the conditions of economic demand. There is a demand for simple and complicated, for highly efficient and very inefficient, engines; for engines adapted to skilled and unskilled operating labor; and for engines to meet a multitude of local requirements, none of which can be formulated, but all of which result in a real demand which the designer and builder must satisfy. Thermodynamics most positively indicates the superiority of gas engines over steam engines; yet the progress of gas engines has depended little, if at all, on this long-known principle, but rather on entirely outside practical considerations such as difference in first cost, size, space occupied, repair and maintenance costs, and the nature and quantity of labor required for their operation.

All these conditions, and many more, enter into the question of true economy, and are entirely outside of the consideration of thermodynamic economy. Therefore, any theory of power-generating machinery which fails to include the various factors of cost (including labor as well as capital charges) and their variations with local conditions, is not a complete theory and therefore not a theory to teach engineering students. These mathematical laws are very valuable in explaining results attained and preventing attempts at the impossible, but not nearly so useful in that prediction of results, which is the prerequisite of design of whatever sort, as many of their professional advocates have for years taught their students to believe. For many

years past the average course of study absolutely ignored all those subjects or methods of treating subjects that were not capable of formulation. The labor and cost questions, although they are at least of equal importance, have been ignored; while the mathematical or pure technological has often been carried to absurd extremes. It is almost a proverb among graduates of the engineering schools that fully half of the instruction they received contributed no more toward the practice of their profession, nor to the true preparation for it, than may be included under that vague term "mind training," which "mind training" might just as well have been secured by the treatment of other subjects of greater contributory value.

Ideals and theories are always beyond doubt absolutely essential. It is not the purpose here to belittle them, but rather to place them in their proper position as partially and not by any means wholly preparatory subjects. It is indeed important to teach students to lay out machines, to determine the forces in the mechanism, and to proportion the parts to resist resulting stresses, but it is equally important that they be taught what a great variety of machines might be designed to perform precisely the same thing, perhaps with various degrees of goodness, but certainly with great variations in cost not only to build them but to operate them. Unless a machine can be built cheap enough to meet the demand it should never be built, and there is absolutely no use in designing a machine if its cost of production or operation exceeds what can be properly paid. It is certainly important to teach the student how a bar can be turned round or a plate made flat, or how every operation necessary to make a machine may be carried out by a mechanic; but it is equally important that he should know their relative costs so that he may avoid the expensive operations or reduce their use to a minimum. He should also be taught that the maximum economy in producing that machine will result when it is made in quantity, and that quantity production will involve changes in design, changes in shop processes because it permits the use of special instead of standard tools, and finally, and most important, that quantity production involves many men, and that many men require management that each may produce the maximum for his wages, and that such an organization for economic production is subject to laws and principles of far greater consequence than all the thermodynamics that was ever formulated.

It is because the old courses of study have failed to correlate properly conditions of commercial economy with conditions of pure technique, or because they have been academic rather than practical, or be-

cause they have contented themselves with contemplation of the results of the past and with elaborate discussions concerning these results rather than with the work of the present and its essential requirements, that differences are now springing up between the schools. The more alert minds, most closely in contact with practical affairs, are realizing this situation and contributing to its improvement. It is too much to expect of any one man teaching our students, in a course with such aims as should apply to the training of the mechanical engineer as the developer and organizer of our technical industries, that he should be equally well equipped in all quarters. There is probably no such man in existence. Dependence must, therefore, be placed on various workers, each in his specialty, to contribute his mature judgment on the relative weight that is to be given not only to the possible available subjects, but also to the possible methods of treating them.

It must be recognized, however, that no course of study which consists wholly of commercial subjects is sufficient to meet the present demand of industrial education. Such subject matter must be so incorporated and correlated, and presented by such methods of instruction, that there can be no leaning to the one side or the other, but the absolute interdependence of the two shall be shown. Without that training in the analysis of observations, in deduction from them, and in the drawing of generalizations and the correction of generalization by further observation, which is the result of the purely, technical training, and which leads so positively to systematic thinking and orderly mental procedure, a successful attack upon the problems of organization and control of great industries cannot result; and without it they would not exist today. Such rigorous habits of thought cannot be developed by the simple business training alone, but when applied to business problems they will surely yield results. It is these qualities, developed by the mechanical engineer in the practice of his profession—not always because of the school from which he graduated, but too frequently in spite of it—that have made possible the enormous progress in manufacturing in recent years. Their importance is indicated by the report of the last president of the American Society of Mechanical Engineers, which shows that over 50 per cent of the members of the society are directly concerned with the organization and management of capital and labor, while the rest are either engaged in the practical preparation for this work or in strictly technical pursuits.

For some time past the department of mechanical engineering at Columbia University, under the direction of Professor Charles E. Lucke, has had under consideration this general problem, and the

result has been the establishment of a new course of study which, it is believed, is a step in the right direction; it is submitted as one attempt to bring about the desired result. The entire four years of student work has been revised and co-ordinated, both in subject matter and methods of instruction, with the above aims in view. It is felt that the preparatory and fundamental subjects of mathematics, mechanics, chemistry, physics, shop work, and drawing should all be made to lend themselves to the oneness of purpose so essential for the accomplishment of good results. Mathematics, which establishes the relation of dependent quantities, the laws by which the functional relations may be predicted by deduction from formulated observations; deductions; mechanics and physics, which treat of the laws governing the relation of forces, their action on masses, their variation with respect to time and space, together with the basic ideas of energy, heat, light, electricity and magnetism, and the properties of matter in solid, liquid and gaseous form; and chemistry, which goes still farther into the question of force relations in their molecular aspect and which leads to the clear conception of the constitution of matter and its possible and impossible transformations—all lend themselves most admirably to exposition by means of elementary engineering problems. Such problems serve to give these fundamental laws the forms and associations required for the work of the engineer, and to make them become real instead of mere word statements in the student's mind. The necessary conceptions can never be considered acquired unless the student becomes their master by using them, instead of being mastered and repulsed by contact with them. By replacing a large part of the hand work of the manual-training shops by lectures and demonstrations, and by alternative practice in pattern making, forging, machine and foundry work and the exposition of their relative economic values, critical comparison—of great value in its future application for this type of man—is substituted for muscular effort and finger-skill, for which he has little application. The elementary ideas underlying modern drafting-room practice, followed by later applications, are substituted for work of the old type—drawing instruction involving the making of geometric figures and the solving of trick line problems. Such a preparation in the early days, involving the same subjects as heretofore taught but with different proportional allotment of time and methods of treatment, makes a proper foundation on which to base the more strictly engineering instruction. A tabulated statement of the subjects constituting this course of study leading to the degree of M.E., and the time devoted to each, is given on the opposite page.

FIRST YEAR.

First Half Year.	Hours per week. Class.	Lab'y.
Analytical Geometry ...	3	
General Inorganic Chemistry	4	
Elementary Mechanics, Properties of Matter and Sound	5	
Engineering Drafting ..	1	14
Descriptive Geometry...	3	
Gymnasium		2
Total.....	16	16
Second Half Year.		
Spherical Trigonometry.	2	
Analytical Geometry....	3	
General Inorganic Chemistry	3	
Light, Heat, Electricity and Magnetism	3	
Qualitative Analysis ...	4	13
Theory of Surveying...	2	
Gymnasium		2
Total.....	17	15

SUMMER WORK: Five weeks surveying practice.

SECOND YEAR.

First Half Year.		
Physical Laboratory....		6
Elements Electr. Eng...	2	
Calculus	5	
Industrial Chemistry....	3	
Empiric Design	2	3
Structural Drafting		3
Steam Power Machinery	3	
Pattern Making		6
Gymnasium		2
Total.....	15	20
Second Half Year.		
Elements Electr. Eng...	2	
Analytical Mechanics....	5	
Industrial Chemistry....	3	
Kinematics		6
Steam Power Machinery	3	3
Machine Shop		9
Iron and Steel.....	2	
Gymnasium		2
Total.....	15	20

SECOND SUMMER: 125 hours in College shops; 6 weeks practical work in shops and drafting rooms of manufacturing establishments, with report. A total of 9 weeks.

THIRD YEAR.

First Half Year.	Hours per week. Class.	Lab'y.
Direct Current Lab....		3
Dynamo and Motor Practice	2	
Mechanical Laboratory..	1	3
Resistance of Materials.	5	3
Metal Work		6
Machine Design	1	6
Thermodynamics	2	
Technical "	2	
Total.....	13	21
Second Half Year.		
Electrical Plants	2	
Hydraulic Laboratory... / Metallographic " ...	1	3
Hydraulics	2	
Tech. Thermodynamics.	2	
Materials Testing Lab..		3
Mechanical Laboratory..	1	3
Principles of Machine Manufacture	2	
Machine Design	2	6
Standard machinery for pumping, compressing, elevating and conveying, heating and cooling	6	
Total.....	18	15

THIRD SUMMER: 6 weeks practical work in power plant, with report.

FOURTH YEAR.

First Half Year.	Hours per week. Class.	Lab'y.
Alternating Current Laboratory		3
Electric Power	2	
Electrical Distribution..	2	
Engine Design	6	12
Mechanical Laboratory..	2	3
Steam Turbines	2	
Seminar	1	
Total.....	15	18
Second Half Year.		
Industrial Law	3	
Economics	3	
Gas Power Machinery..	4	3
Water Power Machinery	3	
Manufacturing Plant Design	2	3
Power Plant Design....	3	6
Works Management....	2	
Total.....	20	12

In all those courses which are of a direct engineering character, constant reference is made to the commercial relations in which the problems arise and create necessity for their consideration, while at the same time a most rigorous treatment is maintained of their mathematical and analytical aspects constituting the pure technology of the subject and its scientific basis. Nowhere is superficiality allowed to creep in. Habits of independent thought are fostered and the powers of observation and judgment cultivated in all the work in class rooms, laboratory, and drafting room, by repeated analysis of existing situations, and attempts to apply the generalizations there developed to the synthetic type of problem by designs and projects. It is recognized that the function which the mechanical engineer serves demands that he be possessed of analytical and executive ability, a capacity for bold and independent thought, and the power of selection, which is born of a broad and thorough kuowledge of his subject and which cannot be acquired by any process of instruction that requires the student perpetually to absorb what he is told. Possessed of such qualities, his information becomes an instrument in his hands, subordinate to his habits of orderly mental procedure which always yield results in the attack of new problems, however strange. The experimental work in the laboratories serves as one valuable means toward the development of clear, fearless thinking, while, at the same time, it serves to fix the principles taught in class by giving the student opportunities for personally demonstrating them to himself. The laboratory systems by which it is sought to bring this about have been set forth in a paper* by Prof. C. E. Lucke, head of the department.

For each afternoon's work per week in the laboratory there is assigned one lecture per week, at which the problems to be solved are assigned and the method of attack explained and illustrated by examples. Before performing the laboratory work the student must prepare for himself the first three of the seven paragraphs in his report, which are given below:

WORK TO BE DONE BEFORE THE EXPERIMENT.

1.—Concise definition of the problem to be solved. This is given by the instructor, and in practice often includes several problems more or less interdependent to be solved; in this case each being stated separately.

2.—Justification of the problem. By an examination of the problem in the light of experience or theoretic principles the nature or magnitude of the results demanded by the problem will be found to be wholly or partly impossible to predict, and hence must be measured. This is intended to induce the preliminary application of a man's whole fund of experience to the case in hand and to assist, by so doing, in the solution.

3.—Analysis of the problem in the light of available apparatus and basic principles, to such detail elements that it becomes possible to set down a list of observations to be made and a list of assumptions or constants needed and where they may be found.

* Trans. A. S. M. E., The Function of Laboratory Courses in the Engineering Curriculum.

After the completion of this examination of the problem the student is ready to begin experimental work, and he is not permitted to do so until he has handed in his preliminary report with the study of the subject as explained.

In the laboratory his attention is devoted to finding the answer to the problem rather than filling in columns or wondering what to do with the reading of some thermometer, or what good the reading is after he has it. This leads naturally to the rest of the report, which contains paragraphs each with a guiding title as follows:

WORK TO BE DONE DURING AND AFTER THE EXPERIMENT.

4.—Results of the observation with as much of the method of making them as is necessary to judge of their quality or limits of application under new conditions. This is really nothing more than a brief summary of the actual experience in the laboratory.

5.—Answer to the problem, using the observations and assumptions found by the analysis to be necessary. Where the answer involves a variation of one thing with anything else the nature of the variation is indicated by plotted curves.

6.—Accuracy and errors. In this part of the report it is freely acknowledged that nothing found experimentally can be absolutely right, but results may approach accuracy more or less. Three errors are to be considered:

(*a*) Apparatus error, due to unfitness or lack of adjustment as affecting observations.

(*b*) Personal error in all work.

(*c*) Resultant error due to accumulation or neutralization of many elementary instrumental and personal errors.

7.—Interpretation of results. The full significance of the results is not always apparent by mere statement, but requires some study to clarify. The interpretation usually takes the form of an explanation of the results, or the probable reasons why things were as they were found.

When by this method the student has arrived at an answer to his problem he is immediately conscious of success, and not only confident of the results for the next case, but eager to attack anything. He has thought out the basic principles involved in the problem, found for himself its elements and made observations which he himself decided were necessary, and obtained generally in spite of the stress of noise, heat and other annoyances.

The working out and interpretation of results calls again for application of all the principles known and comparison with results of other experiments, and might well be the daily experience of any of our best engineers, while the clear writing of a concise report on the whole process is likewise no more or less than common engineering practice.

These methods are applied to all of the laboratory work, of which it will be noted there is considerable, running through the courses in gas-power machinery, water-power machinery and steam-power machinery, in addition to those courses specifically devoted to it.

The conduct of the work in the drafting room is also designed to accomplish these same results. The ability to recognize fundamental principles and economic conditions in practical problems is considered just as essential as a knowledge of the principles and conditions as such. Accordingly, therefore, the student is required to determine for himself, from the conditions of operation and service, all the factors requisite to the design of many classes of machines and their component parts. The knowledge and experience thus gained, together with the instruction in the principles of machine

manufacture, is the basis of the work in synthetic design of machines for the performance of specific functions. Preceded by instruction in those factors in design which do not submit to formulations but which are largely evolved from commercial considerations; in kinematics, dealing with the forces and the relations of forces, reactions and interactions, paralleled by the instruction in shop processes; manufacturing-plant experience in the summer months; the principles of machine manufacture, machine design; metallurgy; resistance of materials, and materials testing laboratory, there is established a series of courses as outlined below, which serve as the necessary preparation for those courses which deal directly with the problems involved in industrial engineering, such as manufacturing-plant design and works management; the nature of these may also be seen from the given outline. Space limits confine the definition of most of the courses to the descriptive title alone. In some which exhibit best the recognition of economic elements, the main skeleton of the topical division is indicated. For further details, reference must be made to the catalogue of the university.

EMPIRIC DESIGN—Proportioning of Machine Parts by Empiric Methods and the Production of Shop Drawings and Sketches. Modern practice.

KINEMATICS OF MACHINERY—Determination of Paths of Motion, Velocity, Acceleration and Kinetic Forces of the Moving Parts of Machines with the Resulting Reaction Forces of the Frame.

MANUFACTURING PLANT SUMMER WORK—Practical Work and Directed Study in the Shops and Drafting Rooms of Representative Manufacturing Establishments with Report. Each student is provided with a printed copy of the things to be studied and reported on in detail.

Functional operation, characteristics and powering of machine tools, capacities, layout of shop, size of shafting, belting and motors for independent and group drive. Report on specific observations on time of setting work, time of forming and finishing, number of pieces turned out per hour. Facilities for producing pieces in quantity.

Machine tools used in the pattern-shop, arrangement, capacities, adaptability, handling and storing of material and finished product.

Appliances used in the foundry and forge. Methods of molding. Time involved. Composition of the charges and mixtures, temperatures, pressures, time required to charge, to melt, to pour, cool and clean. Time involved in production.

Drafting Room. Standards and conventions used. Standard parts in stock.

General Mangement and Organization. Methods of recording time of workmen and their time distribution over on different jobs. Drawing of materials used from storeroom and charging to orders.

PRINCIPLES OF MACHINE DESIGN—Analysis of the Stresses in Machine Parts of Standard Form under Varying Conditions of Service and the Proportioning of the Machine Elements to Safely Resist the Resulting Stresses.

PRINCIPLES OF MACHINE MANUFACTURE—The Economic Elements in Shop Processes, Time and Power per Unit of Surface Finished or Cut and per Unit of Metal Removed with the Conditions for Most Economic Production. Processes in the shop, functional operation of machine tools and limits of economic production, time of setting, handling, forming and finishing of parts for job and repetition work in quantity. Limits of time, power and cost for

finishing surfaces per sq. in. and removing per cu. in. and per lb. by hand and machine operations. Economy of portable tools. The selection of economic cutting conditions and analysis of recent experiments. Adaptation of economic cutting speeds to machine tools. Labor-saving devices. Limits of labor, power and fuel per ton of castings. Labor and power per lb. of forging as affected by tools, size and form of work.

MACHINE DESIGN—Application of the Principles of Kinematics, Resistance of Materials, Design of the Machine Elements, Shop and Foundry Methods to the Design of Complete Machines. Analytic and synthetic treatment.

WORKS MANAGEMENT—Manufacturing Organizations and Methods of Accounting. Effect of methods of manufacture and capacity on systems of management of mills and factories. Analysis of the elements of factory accounting and determination of the factors entering into the cost of production. Methods for keeping record of the cost of labor and materials in the production of specific articles. The determination of establishment charges. Interpretation of costs and use of comparative values. Organization and functions of the department of the business. Purchase of raw material and sale of product. Utilization of scrap and waste. Factors affecting the cost of production.

MANUFACTURING PLANT DESIGN—Methods of Procedure for the Design of a Plant for the Manufacture of an Assigned Product at a Given Rate. Determination of kind and quantity of materials needed, processes by which they may be most economically worked, selection of machinery for each process, determination of the number of each kind of machine required, power necessary to drive. Layout of shops for most direct production. Estimate of costs of equipment and installation. Layout of heating, ventilating and lighting systems, power transmission systems and facilities for reduction of fire hazard. Layout of system of management and cost determining system.

Developed parallel with the courses which constitute the "Design Series" are courses which deal with the performance of machinery. The functional operation of power-plant machinery, the development and applications of the laws of thermodynamics exemplified by the laboratory instruction, hydraulics, and hydraulic-laboratory and practical power-plant instruction in the summer months, are subjects contributory to the proper consideration of the work in power-plant design and water, steam, and gas-power machinery. The scope of the work in this series of courses may be learned from the following brief descriptions:

STEAM POWER MACHINERY—Functions, Forms and Principles of Operation of the Typical Steam Power Plant Units, Auxiliaries and Connecting Elements. Methods of receiving, storing and firing coal, coal handling machinery, grates, stokers and furnaces for the combustion of coal; flow of gases through boilers, flues, dampers; operation of boilers, boiler settings and foundations. Methods and apparatus for feeding water to boilers. Flow of steam from boilers to engines, and the grouping of engines and boilers, piping, valves, fittings and pipe covering. The heating of boiler feed water in feed water heaters and economizers. Boiler strength tests and inspection laws. Steam pipe condensation and drainage. Steam traps, separators, steam superheating and superheaters. Condensing operation of steam engines. Typical steam engines and the variations in form and character of their important parts. Regulation of engines and engine governors. Relation between engine construction, foundations, vibrations and balancing. Steam turbines. Typical steam plant arrangements for various special and standard conditions.

Afternoon work in laboratory, power house and drafting room, sketching apparatus, setting valves, plotting diagrams and demonstration of principles of operation taught in class.

TECHNICAL THERMODYNAMICS—Laws of Heat Generation by Combustion, Heat Transfer and Transformation into Work.

GAS POWER MACHINERY—Theoretical and Practical Consideration Affecting the Generation of Power by Gas Engines, Including Oil Vaporization, Coal Gasification and the Design of the Machinery. Efficiency.

WATER POWER MACHINERY—Principles of Design and Economy of Operation of Turbine Wheels and Water Power Plants.

POWER PLANT SUMMER WORK—Report based on not less than six weeks' practical work in an Operating Power Plant, including the Output, Load Conditions, Labor and Material for Operation and Maintenance, Operating Cost per Unit and the Essential Dimensional Relations between the Various Units and Auxiliaries Producing this Result.

STEAM POWER PLANT DESIGN—Relation Between the Cost of Power and Thermal Efficiency of the Plant. Commercial Value of Refinements. Determination of engine and boiler ratings and corresponding efficiencies and probable coal and water consumption for plant on given load curve, etc.

The work done by the students during the summer months in manufacturing and power plants, which has been referred to, has been a source of much good in promoting the asking of questions and the inquiring into conditions which they could not understand, in arousing an interest in the work of the subsequent years.

Because of the inherent difficulties of treatment and the necessity of further exemplification of the laws underlying the design and performance of machinery, there is incorporated a series of courses, the treatment of which is according to the system of Case Law. As in the practice of law, so also in the practice of engineering it is found that the principles underlying and interwoven in the structure of the problems presented for solution are comparatively few, while their applications and modifications are many. It seems expedient, therefore, that for a direct preparation for the practice of engineering, as for the practice of law, requiring such rigid analysis for the discovery of underlying fundamental principles and the untangling of the many exemplifications, the case system should be adopted.

To this end there has been included in the course of instruction a series of subjects concerned both with design and performance, experimental investigation, and economic considerations which are also treated after this system. These subjects are air machinery, pumping machinery, elevating and conveying machinery, refrigerating machinery, gas-power machinery, and steam turbines, thus outlined:

ELEVATORS AND CONVEYORS—Mechanical Handling of Solid Materials by Standard Elevating and Conveying Machinery, Characteristics, Speed, Tonnage and H.P. per Ton, Computations and Adaptability to Special Service. Hand handling of materials, limits, cost and conditions warranting use of machinery. Pneumatic and hydraulic elevators for freight. Passenger elevators, rope and plunger types. Automatic weighers of materials; coal and ore storage systems. Excavating machines and dredges. Coal and ore handling machinery. Coke oven chargers and dischargers. Grain handling.

REFRIGERATION MACHINERY—Relative Equipment, Space Occupied, Fuel and Water Consumption per Ton of Refrigeration or of Manufactured Ice for Principal Systems.

AIR MACHINERY—Structures, Adaptability and Economy of Fans, Air, Gas and Vapor Compressors, Blowing Engines, Jet Blast Apparatus and Important Applications.

PUMPING MACHINERY—The Mechanics of Moving Liquids and Standard Machinery for Pumping. Water elevators.

As a necessary adjunct to this complete consideration of the commercial relations in which all problems in engineering are involved, instruction is given by the Departments of Law and Economics in the principles of industrial law and economics, and in their application to relations and responsibilities between man and man and to the affairs of groups of men.

In the desire and necessity for a closer co-operation between the conditions involved in our educational system and their connection with the practice of the profession, which has previously been mentioned, there have been secured the services of men in practical life who through their years of experience and thorough training are qualified to give instruction in the several subjects, advise in all the affairs of the department which concern the course of study, and thus serve to make this bond. These men have been assigned to the conduct of those particular courses mentioned under the "case law" for which they are particularly fitted. The work of these special lecturers, with the assistance of the instructors in the laboratories, recitation and drafting rooms, is not accompanied by any departure from the regular methods of instruction pursued in the other courses and is not to be confused with the general system of special lectures on isolated and non-related subjects which is also carried out by our student engineering societies.

In the last number of this magazine there appeared an article by Prof. Hugo Diemer of the State College of Pennsylvania on a proposed course in Industrial Engineering aimed to prepare men for leadership of our industrial enterprises. In view of the opinions which I have attempted to bring out in the foregoing, it seems hardly necessary to state that I think the plan both inadequate and misdirected. A few words may suffice to make this clear.

It appears that while there are several good subjects scheduled, such as Banking, Theory of Money, Factory Administration and Commercial Law, there is an entire lack of good mechanical-engineering instruction so necessary for the industrial work of which it is the foundation. The author states that it is necessary for the industrial engineer to be "thoroughly familiar with productive processes," yet at the same time he proposes to devote only one hour per week

in one term to instruction in "shop methods," which may not even be on the processes of production.

There is nothing offered in technical thermodynamics, the foundation of all work in steam and gas engineering, yet in the senior year there is scheduled a course in "Gas Engines, Refrigeration and Turbines." Without thermodynamics these courses can only be descriptive and superficial. There is nothing on machine design, which subject together with the principles of machine manufacture, and leading to instruction in manufacturing-plant and design and works management, is the very foundation of Industrial Engineering instruction. With the exception of a few hours instruction in electric measurements, there is nothing whatever on Electrical Engineering in its broadest sense.

Such courses are vastly more important than Quantitative Analysis, History of Architecture, Architectural Drawing, Bridges and Roofs, Theory of Structures, etc. The industrial engineer is very rarely concerned with these things. He is concerned, however, with machinery and all the relations of machinery to human affairs.

The author further states "The men we must provide must be trained in three distinct lines. They must be thoroughly grounded in engineering. They must have creative ability in applying good statistical and system methods to production, and finally they must know something about men." In the proposed schedule I fail to see where a thorough grounding in engineering is given. I do not hesitate to say that with so little instruction in engineering, the student would know practically nothing about the subject and especially of those things which are the very foundation of the manufacturing industries. Upon the second point, it does not appear how the creative ability of the student can be developed in this particular unless he thoroughly understands the design and construction of machinery and the methods of production—unless he knows how and what to produce. The third purpose is "to know men" and "train for leadership." The first essential for leadership is the capacity for bold and independent thought. A leader must possess the ability to picture clearly in his mind the course which must be followed to bring about the desired ends, must possess the executive ability to organize his forces so that every effort is directed toward the accomplishment of his purpose. And it is believed that the courses of instruction should be so conducted that these qualities must be exercised to the end that the student may know if he does or does not possess them. Leadership cannot be taught in school—it may be developed from experience in life.

OBTAINING ACTUAL KNOWLEDGE OF THE COST OF PRODUCTION.

By F. E. Webner.

III. COMPARISONS OF COSTS AND THE PROFITABLE USE THEREOF.

Mr. Webner's series began in our May issue, and previous numbers have discussed "What Constitutes a Knowledge of Costs" and "When and Where a Close Knowledge is Needed." The parts following after this month will be: "Use and Abuse of Mechanical Aids in Cost Finding"; "The Organization of the Cost Department"; and "Cost Records as Part of the General Accounting."—THE EDITORS.

THE end and aim of cost accounts should be to know, not how much a certain shop order cost for its constituent production elements, but *why* it cost what it did and under what conditions the cost might be reduced.

The "Material" element is not without its need of comparisons, as it frequently discloses the need of buying at closer figures, or possibly the advantages of a judicious use of some "just as good" material, or again the desirability of contracting for a season's supply rather than relying on "pick-ups."

Perhaps the most important element to compare and watch carefully is the labor; the length of time spent on a job often involves the difference between a profit or a loss on the work, and inasmuch as the number of hours spent on the job affect the burden of expense as well as the labor cost, it is quite essential to scrutinize the cost records and to compare time of operations with time previously spent on similar operations, and to set about to learn the cause. Inefficiency of foremen or employees is often brought to light, the discovery resulting in improved labor conditions; and that, incidentally, is the most potent factor in the minds of workmen against the introduction of cost records. Records mean, fundamentally, the assurance of a full measure of value for all assets in the transition from one stage or state to another state or condition; hence friction results.

Aside from certain conditions, the grumbling of workmen should not be seriously considered when a cost system is being installed, else it will never come to a point where it discloses any facts not already known.

It is a foregone conclusion that both foremen and workmen will frown on any attempts to get accurate data concerning labor operations. The foreman may, to all appearances, evince a desire to advance the best interests of the management; but his heart usually is with his men and their wishes when it comes to putting one man against another in tests of speed for record; that is especially true with foremen who have served their time in subordinate capacities in the particular department over which they hold sway.

Instances are not few in which rapid piece workers have been let out for no cause whatever except that their "excessive" production caused dissatisfaction among less-nimble-fingered workmen; such cases however, were in times when labor was in sharp demand and a workman might at any time find another job across the street; then the whims of disgruntled workmen carried somewhat more weight than they do in times when factories run on part time only, and the general run of workmen are glad enough to be kept busy.

The management of a factory should be alone the judge of how far it will allow the workman to dictate the policies of the business; the introduction of a cost system may embody plans which might set the teeth of the workman on edge and cause serious labor difficulties, and therefore such plans must be diplomatically launched and carefully guided in order to avoid disturbances. It is not the purpose of this article to tell just how such plans may be carried out as regards the workmen, for each factory is a case peculiar unto itself and must be specifically treated with remedies best known to, or worked out by, the management. One bright superintendent was able to load cars and have other manual labor done where groups of men could be utilized to advantage, by fanning the flame of race prejudice—Irish *versus* Germans, Norwegians *versus* Poles, etc. If the contending groups were not working simultaneously, then a glowing record of achievement was always available for reference and the group of workmen nearest at hand were gibed into a contest to equal or surpass the record. This plan was started as a joke, but latterly carried on in all earnestness purely as a means of reducing the cost of handling material; and before the men realized what had been done they had all acquired a quick movement which was not allowed to lessen through lack of urging; here was a profitable use of comparisons.

In order to make any use whatever of comparisons of labor operations on parts of product, the starting and finishing time must be required, and not merely an offhand statement on the time report that each operation or job performed took a certain amount of time; the

latter plan is too prolific of possibilities to doctor the time report either intentionally or unintentionally—the man may be honest and yet easily make a mistake in the time unless he puts it down, and if he is to put it down at all, let it be on the time ticket; then it is authentic.

Where starting and finishing time is required on each job or operation, the full benefit is not being derived therefrom if a close record and sharp watch are not kept of the variations in time required on a given operation; for this purpose a record card should be maintained for each constituent part of the product, with a full classification showing each operation wherever such operations are singly performed. The successive entries should show date, name of operative, number of pieces finished, elapsed time, and time per unit. At intervals an average time per unit should be shown, and the secret of any success or benefit arising from the plan is to have the records always up to time as far as posting is concerned. If comparisons demonstrate that a certain man has far exceeded a reasonable time per unit on a given job, then while the matter is still fresh the reason can be ascertained through proper channels and a possible remedy applied, whereas if the records are four or five weeks—or even one week—behind the actual work, the workman can very conveniently have forgotten all about it; in which event the records avail nothing and the time spent in maintaining them will have been practically wasted.

Where records are promptly posted the men very soon learn that they are being closely watched, and there is much less dead time likely to exist than where the men are to a large extent given their freedom with but an occasional rebuke by the foreman. Habitual slowness of one man on a certain kind of work will demonstrate, perchance, that he is too expensive on the work, and duties for him can be found which are confined to operations more in keeping with his natural bent; thus the system operates to cut down costs. It frequently happens that one man can prepare a tool or machine in less than half the time other men take to do it, and this difference in time of preparation possibly accounts for a glaring difference in the time per unit required for the operation considered as a whole. In some shops the setting-up process is done on time work, while the subsequent operation is on a piece-work basis, so that there is often a tendency to postpone the time-recording act as long as possible, in order that piecework operations may be taking place while the "time" also is going on. This is nothing more or less than petit larceny; men who are detected at this trick usually ought to be watched, as they are more than likely to repeat it as often as the opportunity presents, and in

cases of this kind the records should show the setting-up time separate from the balance of the operation so that close tab can be had on the time work. The deferred-time-recording trick is attempted in many cases where the premium system is in vogue; when a workman for any reason has time to spare on the job just finished he will start on the new work and not ring or record "out" in the finished job until the spare time is consumed. The most sure preventive of this act is a penalty to be levied against his premium whenever he is discovered at it, and the comparisons to be made in this sort of case are in the factory and not in the cost office. The foreman should make it a practice to make a number of trips during the day, going the rounds of his department to scrutinize the job tickets of every employee. These trips at irregular intervals should cause no hardship, but rather the reverse, as the foreman should necessarily be in close touch with the work of the men—that is what he is or should be there for. In some cases it is possible without loss of time to have the next job ticket issued only after the preceding job is completed, or again each workman can have two or three jobs laid out ahead of him with definite instructions given him for each, but he may not be allowed to know which he is to take up next until he finished the preceding. For this plan a good arrangement is to have a rack for job tickets, and to have the rack equipped with an electrical contrivance wherein each workman's tickets are placed face inward on a separate hook or ring; each ring is so connected that when opened (to remove a job ticket) it breaks a circuit, thereby electrically recording the hook number and the time the ticket was lifted.

Every works manager knows that a group of efficient workmen if left entirely without a pusher would have "Fat Costs and Lean Production." An old axiom says that comparisons are odious, and that is quite as true in factory comparisons as elsewhere. With a comprehensive system of comparisons, the workman to whom such comparisons are odious is forced to put forth such efforts as are necessary to bring his work up to or above standard, and by those efforts he can change the conditions so that "Fat Production and Lean Costs" will result.

EDITORIAL COMMENT

A photograph of "a mile of idle engines," 120 in number, was recently taken by the New York Central and exhibited as "an argument for raising freight rates." The economic twist of this argument, as a leading editorial writer remarks, is very curious. If selling goods were in question, instead of selling transportation, the futility of meeting the depressed conditions by raising prices would appear quickly enough. The railroad point of view seems to be rather that of the man who "needed the money."

Curiously enough, the New York Central is also the road which has startled the industrial quiet by placing an order with the American Locomotive Co. for 139 new engines. Evidently the officers of the road are sure not only of early use for the mile of idle engines, in such service as they are fitted to perform, but also for a mile and a quarter of new and better engines. As the writer just referred to asks, why not photograph the new construction with its gospel of optimism, instead of the passing evidences of depression and pessimism?

The enormous and often-opposite variations in our industrial energy and the load put upon it, constitute one of the greatest inefficiencies of our era. A year ago the overload was almost universal—factories swamped with orders, shops running overtime, freight congested everywhere, and railroads hopelessly unable to handle the volume of business pouring in upon them. Construction suffered expensive delays waiting for material. Shippers fumed over the car shortage which deprived them of facilities for moving away goods sold to make room for fresh raw material. And now, quickly forgetful of the past, and needlessly skeptical as to the future, priceless time is allowed to slip idly by; costly equipment stands motionless; productive capacity rests unused, as if there were never to be a demand or an active market any more. The curious part of it all is that every one knows the overdemand will soon appear again, and the days now passed in idleness will be paid for in overtime at high wages and at low proportionate output. If we could but have a regulator of some sort, to store our power of production at times of light load and help us again by returning it when the load reaches a peak!

For those who can seize it an unusual opportunity is here. An editorial in "The American Lumberman" defines it thus, as it appears in the building trade:

"It is possible now to secure more and better work for the same price than at any time within the last two years. Materials are cheaper, labor is cheaper, anxious for employment and earnest in its desire to give full value. These certainly are factors which the wise investor should take into account.

"Lumber, brick, stone and other materials necessary to the construction of buildings, purchased and put into place at this time, will be worth in the new relation they bear one to the other a great deal more a year or two from now than the present cost. Furthermore such structures will be ready for use."

The same conditions apply in many lines of mechanical and engineering work.

With the progress of the summer, the much-magnified "uncertainties of the future" will shrink to nothing and disappear. Resumption will become a very simple thing, and with resumption prosperity will return.

"The way to resume is to resume."

The Province of the Engineer.

THE movement for a readjustment of engineering education, now appearing in many of our greater colleges and universities, is realized to be of so much national importance that it is to engross the attention of the summer conventions of two great professional societies—the Institute of Electrical Engineers and the Society for the Promotion of Engineering Education.

It seems to result from a general awakening to the breadth of the field the engineer is called upon to occupy. He is no longer merely a technician—a designer of machines or structures—a professional adviser on the theoretical elements of any problem in his specialty. He is more and more generally the actual manager and executive of great productive enterprises, and has increasing need for a sound knowledge of economics, commercial relations, systems of organization, conditions of labor employment—of all the factors involved in efficient and economical production, whether this be of transportation, of structures, of ingots and metal shapes, of machine tools, of textiles. The industries of a great nation, in a century which is characteristically and commandingly an era of manufacturing, are passing largely into the hands of the engineer. His training must be such as to make him soundly educated, broad-minded, professionally conscientious. He must love efficiency, and abhor waste; and that he may know what efficiency is obtainable and whether waste exists, his eyes must be opened to the meaning and value of quantities not to be found in mathematics, thermodynamics, or chemistry.

The increasing pressure of life in manufacturing countries, the growing density of population, and the visible depletion of the natural resources by which we live, must be met and relieved by stopping leaks, saving wastes, conserving our energies, and improving our efficiencies. In the intelligent, earnest, humane pursuit of this philosophy lies one of the strongest hopes for the solution of the great and menacing problems of the day. The lesson will not be learned readily, perhaps, but the common sense of it will gradually prevail and pervade, and early professional teaching of the root ideas will be one of the strongest fostering influences.

The new Gospel of Efficiency is ably preached by Mr. Emerson, whose opening chapter in this issue is commended to our readers. It is a foretaste of possibly the strongest industrial hope of the Twentieth Century.

Costs of Steam Power.

MR. Wm. E. Snow, whose figures of steam-power costs were published in our May issue, requests us to acknowledge his indebtedness to Mr. Chas. T. Main for the original compilations upon which this later work is based. Mr. Main's data were collected ten years ago, for a special purpose; the changed conditions now existing, and especially the rise of prices for materials and labor, make the modern figures entirely different. Mr. Snow adopts larger units also for coal and steam consumption per horse power. His costs in the average run 10 to 15 per cent higher than Mr. Main's. The unit subdivisions and the detailed form of the tables, however, were adopted by him as admirable standards, and the basic data of Mr. Main's earlier work much facilitated Mr. Snow's computations. His thanks are most cordially acknowledged.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE EFFICIENCY OF THE GAS ENGINE.

THE EFFECT OF STRENGTH OF MIXTURE AND OF SCAVENGING ON THERMAL EFFICIENCY.

Bertram Hopkinson—Institution of Mechanical Engineers.

A REVIEW in these columns of THE ENGINEERING MAGAZINE for January outlined the main points of a paper read by Prof. Bertram Hopkinson before the Institution of Mechanical Engineers in October, 1907, which embodied the results of a series of experiments on the mechanical efficiency and indicated power of a 40 horse-power Crossley gas engine. The principal features of these researches were the use of a new optical indicator and a full investigation of the mechanical losses under various conditions. The investigations showed that the methods developed by Prof. Hopkinson for the measurement of gas supply and indicated power gave much more accurate results than those usually employed and the paper mentioned elucidated many obscure and puzzling points connected with gas-engine efficiency. Prof. Hopkinson has since applied his methods to the investigation of the effect of strength of mixture and of scavenging on thermal efficiency. The results of his researches were presented to the Institution of Mechanical Engineers on April 10 and we take from his paper the following extracts which contain the more important of his conclusions.

"The weakest mixture used in these tests contained about 8.65 per cent. of coal gas when in the engine, the proportion of air to gas drawn in being about 9½ to 1. The diagram was quite normal, the explosion line being nearly vertical. Weaker mixtures than this, however, would not ignite regularly. At the other end of the range the proportion of air to gas was about 7½ to 1, the excess of air being about 1½ times the volume of gas; slightly heavier charges than this could be used, but it is possible that the combustion would not be complete, and the pressures in the engine would become dangerously high. The range of mixtures tested therefore covers all which could be practically used. Within that range the efficiency diminishes steadily as the strength of mixture increases, the difference between the weakest and strongest charge amounting to 4½ per cent. in efficiency, or 12 per cent. on the work done.

"That the efficiency will increase as the strength of mixture is reduced, so long as the combustion is substantially complete, is to be expected from the now well-established fact that the specific heat of the working substance increases with the temperature. The work done in the gas engine cycle is mainly determined by the rise of pressure which occurs on explosion; and in the same engine the area of the diagram with different mixtures is about proportional to this rise, when corrected for the change in volume during combustion. If the specific heat of the working substance were constant, as is assumed in the air-cycle, the rise of temperature and therefore of pressure at the explosion end of the diagram would be proportional to the heat supply, and the efficiency would therefore be constant. But the specific

heat being, in fact, greater at high temperatures, the rise of temperature or of pressure on explosion increases in a less ratio than the heat supply, and the efficiency therefore diminishes as the supply of heat is increased.

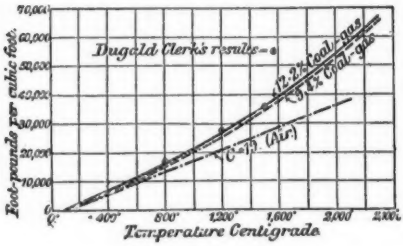


FIGURE I. INTERNAL ENERGY CURVES.

"The ideal efficiency of a gas-engine, by which is meant the efficiency which would be attained if all heat losses to the walls were suppressed, and if combustion were complete and instantaneous at the in-center, is easily calculated if the internal energy of the working fluid is known as a function of its temperature. It cannot be said that we yet possess this knowledge in any high degree of accuracy, but enough is known to enable an estimate to be formed of the effect of strength of mixture on efficiency. Figure I shows the internal-energy curves corresponding to the weakest and strongest mixtures used in these experiments. The ordinate of the curve is the quantity of heat in foot-pounds required to heat a standard cubic foot of the burnt products, at constant volume, from 100 degrees Cent. up to the temperature represented by the abscissa. These curves are calculated from the figures given by Langen for the specific heats of CO_2, H_2O and air, between 1500 degrees and 1900 degrees, and from the results of Holborn and Austin and Holborn and Henning, at lower temperatures. The values given by Clerk for a mixture of intermediate composition are also shown. The ideal engine efficiencies for the two mixtures can be calculated from these curves by the method given in an appendix. The ideal efficiencies corresponding to mixtures containing respectively 8.8 per cent. and 11.4 per cent. of coal-gas, calculated by this method, are 42.4 and 39.4 per cent. respectively. For mixtures of other compositions the efficiency will follow a straight-line law sufficiently nearly for present purposes, and this straight line is shown dotted in Figure II (below). It is worth noting that the two straight lines on that figure, if produced, would cut the line corresponding to a zero gas-consumption, at 50.6 per cent. and 52.6 per cent. respectively. The air-cycle efficiency for this engine is 52.2 per cent. In other words, if it were possible to burn weaker mixtures—say, by using stratification—and if the actual and ideal efficiencies continued to bear a linear relation to the gas-consumption, these efficiencies would tend to become equal to one another and to the air-cycle efficiency with a very small gas-consumption. The ideal efficiency ought, of course, to approximate to the air-cycle efficiency when the charge is greatly reduced; the close agreement in the other case is no doubt, to some extent, accidental, but something of the kind is to be expected.

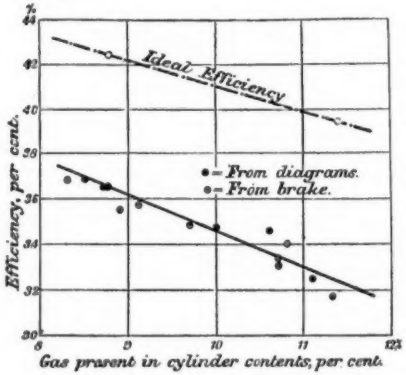


FIGURE II. THERMAL EFFICIENCY.

"Without laying too much stress on the absolute values of the real and ideal efficiencies shown in Figure II, it is apparent from the ratios that they bear to one another, that while much of the superiority of the weaker mixtures is to be ascribed to increase of specific heat, that cause is not sufficient to account for the whole of the effect. Comparing the actual with the ideal efficiency, it will be seen that for a mixture containing 8.5 per cent. of coal-gas the ratio—usually

called the efficiency ratio—is 0.87, but when the proportion of coal-gas is increased to 11 per cent. it is only 0.83; the weaker mixtures, in addition to giving a higher ideal efficiency, come nearer in practice to realising that ideal. This is due to the fact that the percentage of heat lost to the walls during expansion is less with small gas charges than with large. The difference is sufficient to counterbalance an influence tending the other way—viz., the more rapid combustion of the stronger mixtures. This has been established by a series of experiments directed to that end. . . .

"When the engine is running light or partially loaded, so that each explosion stroke is followed by one or more scavenging strokes, the suction temperature is about 50 degrees Cent. as against 100 degrees Cent. when running fully loaded. With a given charge of gas, therefore, the mixture will be weaker under these conditions than when fully loaded, and the efficiency will be correspondingly higher. For example, if the engine is taking 0.11 cubic foot of gas per suction, the percentage of coal gas in the charge will be about 9.6 when running fully loaded, but it will be only 8.2 when the engine is scavenging. Referring to Figure II, it will be seen that the corresponding efficiencies are about 37½ per cent. and 35 per cent. respectively. There is some uncertainty about the suction temperatures on which this calculation is based (taken to be 100 degrees Cent. and 50 degrees Cent. respectively), but making full allowance for that, it may be said that the mean pressure realised with the same gas-charge should be at least 5 per cent. greater when the engine is scavenging than when it is running fully loaded—assuming, of course, that the strength in each case is such as to give regular and normal ignition.

"A number of experiments were made with the object of testing this conclusion. Diagrams have been taken with the engine running light on half-load; and have been compared with full-load diagrams taken at the same time, the gas-consumption being measured in each case. The results of one such test were that a gas-charge of 0.1275 gave a mean pressure of 108.4 on light load, as against 102.2 at full. Further, a charge of 0.100 at full, and a charge of 0.114 at light load, corresponding in each case to a mixture strength of about 8.5 per cent., give approximately the same efficiency of 37 per cent.

"These results were confirmed generally by other diagrams taken at light load, and also by running the engine at half-load, so that most of the explosion strokes were followed by one or more scavenging strokes. The results, however, were not so consistent as in the full load tests, the mean pressure sometimes falling short by as much as 6 per cent. of that which was anticipated from the gas-consumption. In the case of the full-load trials the mean pressure can be predicted from the gas-consumption within 2 per cent. This want of regularity is due in part to variation in the suction temperature, which was always assumed to be 50 degrees Cent. after a scavenging stroke and 100 degrees Cent. after an explosion. As a matter of fact, both temperatures vary to some extent with the number of explosions per minute, and possibly also a little with the gas-charge; there will be corresponding differences between the actual mixture strength and that calculated. But a more important cause of irregularity is the fact that the combustion of a scavenged charge is generally incomplete, the fuel discharged unburnt sometimes amounting to 4 or 5 per cent. In all, four analyses were made of the exhaust when the engine was missing about every other stroke. The quantities of unburnt gas found were respectively 4.2, 3.2, 5.4, and 4.5 per cent.—average 4½ per cent. These analyses are not so accurate as those of full load because of the dilution of the exhaust with air, and there seems to be some selective combustion, as the quantities of steam and CO_2 formed in the combustion tube are usually not in the proportion obtained by the complete burning of the coal-gas. But there is no question that a good deal of unburnt gas is sometimes discharged when the engine is missing explosions. The effect is quite apparent in the heat-balances at half-load, which all show a bigger deficiency than can be accounted for by radiation.

Five trials at half-load showed balances unaccounted for ranging from 297 to 433 thermal units per minute, the average being 350, or about 10 per cent. on the heat supply (higher value). Six trials at full load with the same jacket temperature (75 degrees Cent.), and taken with the same appliances, showed deficiencies ranging from —58 to +189 thermal units; average +25 thermal units. The systematic errors were probably the same in all these trials. The radiation is a little greater in the full-load trials because the piston is hotter, but the difference in this respect cannot be very large. Thus, after allowing for radiation, the heat unaccounted for in the half-load trials is some 300 B. T. U. per minute more than at full load, and this must mainly be due to a greater proportion of unburnt gas. In the last of these trials the thermal efficiency obtained from the brake load by addition of the mechanical losses (separately measured at the same time by observing the light load indicated power) was 32.7 per cent. About three-fourths of the explosions were followed by scavenging strokes, and the gas-charge was 0.1285 as measured in the holder. The average strength of mixture, calculated on the above-mentioned assumptions as to the suction temperature, was 10 per cent., and the corresponding efficiency 34.5 per cent. Thus the mean pressure was 5 per cent. less than that calculated. In this case 4½ per cent. of unburnt gas was found in the exhaust, and the deficiency on heat-balance was 433 thermal units per minute out of a total supply of 3740.

"It is not possible to say how far the combustion is incomplete when the engine is running quite light; but it seems likely, from the high mean pressures sometimes realised under these conditions, that it may under some circumstances be more nearly complete than in the half-load tests. From a study of the latter it would appear that when allowance is made for the gas discharged unburnt, the efficiency is not much affected by scavenging provided the strength of mixture is kept the same, which implies an increase of about 15 per cent. in the gas-charge with, of course, a corresponding increase of mean pressure."

FUEL SPECIFICATIONS AND CONTRACTS.

A DISCUSSION OF THE POINTS TO BE COVERED BY FUEL SPECIFICATIONS AND THE ADVANTAGES OF PURCHASE BY CONTRACT.

William D. Ennis—The Engineering Record.

FUEL, which represents the principal item in the raw material bill of a considerable number of industries and an important item in nearly all, is the only commodity still bought by luck. In the case of all other materials the modern commercial establishment endeavors to fulfil the logical aim of all trading, to buy only such materials as are satisfactory and to pay for only such quantities as are actually received. But fuel is still bought at the valuation placed upon it by the seller and only in rare cases does the purchaser attempt to satisfy himself that the quality of coal supplied him is such as his requirements demand and that the quantities paid for are actually received, or to relieve himself of the burden and expense of providing large storage accommodation by fixed contract regulation of deliveries. The lack of logic in this haphazard method of purchase is admirably set forth in an article by William D. Ennis in *The Engineering Record* for April 25. We abstract from this article the following summary of the points which should be covered by fuel specifications and the advantages which may be expected from the purchase of coal on contract.

The fundamental unit of value in power production is the heat unit and it is illogical to pay for fuel by the ton or carload when the value cannot be measured on scales. The determination of heating value is a simple matter. The calorimetric method is best, but for anthracite or semi-bituminous coals computation from the ultimate analysis gives sufficiently close results for comparative purposes. When coal is regu-

larly received from one source, frequent determinations of heating value may be unnecessary, as the proximate analysis alone indicates any marked variation in quality. The proximate analysis shows the percentages of fixed carbon, volatile matter, moisture and ash. Serious errors may be made in the complete examination of a coal for these constituents and it is necessary that the checking of shipments should be done by an experienced man and preferably always by the same man.

Moisture reduces the heating value of a coal both by taking the place of combustible matter and because of the actual loss of the heat in the combustible portion required to evaporate it. The proportion of moisture is controllable by the miner within certain limits and excessive moisture should be considered as adulteration. Like moisture, ash decreases the combustible portion of the coal, but although almost any percentage of moisture may be permitted if the price is correspondingly reduced, the effect of ash is much greater than would be represented by its numerical percentage. When ash reaches a certain percentage the coal becomes practically useless and proportions below this limit result in losses of value which increase more rapidly than the percentage of ash. The character of the ash is also important. A fusible ash increases the cost of firing, is hazardous to good steam service and is detrimental to efficiency of combustion. The determination of this constituent is therefore of the utmost importance and in the purchase of coal a limiting percentage, based on the dry coal weight, should be set for it.

Sulphur in coal reduces the heating value, but it is particularly undesirable on account of its detrimental effects on grates and boiler surfaces. The sulphur content of coal should be limited arbitrarily to small proportions, a condition readily conceded by shippers.

The percentage of volatile matter serves to classify the coal and since only one class of coal can be burned economically in a boiler furnace of any special design, the determination of the volatile constituents is of the highest importance. On it depends the determination of the suitability of the coal for the plant. In general, boiler efficiency decreases as the volatile matter increases. Increase in volatile matter adds slightly to the heating value and the estimation of a coal's value based on the latter element must be modified by the consideration of the influence of excessive proportions of volatile matter on boiler efficiency and smoke production. Specifications should establish a standard heating value with a fixed minimum limit for volatile hydrocarbons. The determination of fixed carbon checks the determination of the volatile matter and is necessary for the computation of heating value from analysis. When the latter is determined by calorimeter, the fixed carbon may be used as a check on the result.

The idea that the heating value of a coal can be determined only by actual trial under boilers is a delusion. Chemical and physical tests are all that are necessary to determine the relative fitness and value of coals for producing power, so long as tests are intelligently made and only such coals are considered as are by their grade adapted to the general type of boiler furnace installation. It is important of course that the testing system should be as correct and as complete as possible. Accurate sampling is one of the most essential elements of a successful system.

Apart from chemical composition, the two most important points to be covered in a fuel contract are the questions of weights and deliveries. The purchaser should have some check on the sellers' statement of weight and the contract should contain provisions for the adjustment of variations from the billed weight in favor of either the buyer or seller. While it is important that the purchaser should get all the coal he pays for, it is equally important that the seller should be paid for all he delivers. Contract provisions covering the adjustment of weights should be drawn without prejudice to the interests of either party. The question of deliveries is of even more importance than that of weights. It is a fact that even under contract the delivery of coal is uncertain but the buyer should be careful to eliminate

from the contract unreasonable clauses of exemption. It is well to err on the side of leniency but the sweeping strike exemption clauses and other relieving stipulations of some contracts give but little protection to the purchaser and practically leave the question of deliveries under exceptional circumstances to the discretion of the seller.

"The cost of a systematized method of coal purchasing is not great. In large works the sampling and laboratory work may usually be conducted in connection with the other duties of the staff chemist. Even when outside analysts are consulted, the expense is small where a daily or weekly regular report is arranged for. Contracts must make provision for arbitration when an analysis or other result is disputed, the expense of the analysis to be borne by the party at fault. The method of sampling should be carefully provided for in the specifications, samples should be preserved for a stated length of time and the sample taken as provided for should be the only sample recognized. A part of each of such samples could, of course, be furnished the seller if desired. All sampling should be done at the point of delivery of the coal.

"The contract should stipulate a fixed price for standard coal with limiting percentages of volatile, ash, moisture and sulphur and a minimum limit for heating value. Within the limits a premium should be paid for heating value in excess of standard and a forfeit imposed for heating values below standard. Both premium and penalty should be arranged on a sliding scale. This is by far preferable to rigid specifications and a fixed price, since there is no tendency then in times of shortage to accept fuel slightly below standard grade.

"There are many objections raised to the purchasing of coal on specifications. Certain natural objections emanate from the sellers. They claim that they cannot control the quality of the coal; that it costs them so much to dig it out of the earth and they ship it as they find it. Does a slate quarryman expect to have his product valued like Carrara marble? An objection perhaps more logical is that the shipper can sell his coal anyway and does not care to become entangled in elaborate contracts. This is too true. The price of anthracite is increasing and the production of soft coal is not keeping up with the demand. The balance of trade is in favor of the shipper. But it should be remembered that in purchasing coal to specification the buyer is not seeking to get something for nothing; he is not trying directly to get more heat units for a dollar and certainly not more pounds of coal for a dollar. He is simply endeavoring to eliminate variations in what he does get for his dollar and to pay for what he actually gets. When he draws up his specification he knows, or should know, what he can afford to pay for coal of the average grade which he has been getting. He is willing to pay the market price for this and a better sum for better coal. On the other hand, he asks the shipper to take less for inferior coal. This is fair and costs the shipper nothing. Where a flat price and flat heating value are named in the specifications the arrangement is not fair and the shipper must quote a sufficiently high price to insure himself against losses due to the rejection of the coal. The buyer, of course, pays this insurance, and consequently loses. But where the sliding scale is employed there is no reason why competition should be restricted on contracts for the supply of coal to specification. It has been reported that one buyer who inaugurated a system of purchasing to specification was obliged under a sliding scale contract to pay double the former price for one lot of coal. If this is true, it furnishes an extreme instance of inaccuracy in determining the average quality prior to drawing up specifications and of a poorly framed contract, but it shows also that coal specifications do not necessarily injure the shipper.

"With clear-cut contracts regarding delivery the purchaser may know what his chances of securing coal will be under abnormal conditions, and is then in a position to decide as to necessary provision for storage. To be without storage is ruinous, and to provide abundant storage is almost ruinously expensive, not merely on account of the cost of handling, but because of the loss in quan-

tity and quality of fuel. Where cessation of deliveries is in default of contract such expense should be charged against the coal shipper.

"From a buyer's standpoint while the purchase of coal to specification may only slightly, if at all, reduce the coal cost per unit of output, it has the overwhelming advantage that it eliminates variations in the cost of his prime material of consumption. No business is well administered in which there is a lack of definite responsibility for any element of cost, and in the average industry, as coal is now purchased, no individual is fairly responsible for the cost of fuel or of power. This removes a definite standard of efficiency from the engineering force and leads to imperfect operation. In one large plant the coal varied in heating value from 12,700 to 14,300 B.t.u., and in percentage of ash from 8 to 12. There was a considerable production of smoke and some difficulty in maintaining steam at times. By adopting a specification limiting ash to 9 per cent., volatile to 21 per cent. and sulphur to 1½ per cent., with a sliding scale of prices, based on heating value, all troubles were eliminated, the price of coal per ton advanced about 5 cents, the heating value about 2 per cent., and the curve of coal cost per unit of output became a straight horizontal line."

THE PARKER BUILDING FIRE.

RECOMMENDATIONS FOR STRUCTURAL FIREPROOFING BASED ON AN INVESTIGATION BY THE NEW YORK BOARD OF FIRE UNDERWRITERS.

Engineering News.

AS Mr. J. K. Freitag pointed out in THE ENGINEERING MAGAZINE for February, the total destruction by fire of the twelve-story Parker Building in New York, a structure of a type popularly considered "fireproof," contains many lessons of the highest importance to architects and engineers. Mr. Freitag's discussion, it will be remembered, dealt more particularly with the striking demonstration of the necessity for auxiliary fire-fighting apparatus in buildings of this type. An interesting supplement to Mr. Freitag's paper is contained in the recently published report of the New York Board of Fire Underwriters, abstracted in *Engineering News* for May 21. The recommendations contained in this report, reprinted below, give not only the lessons regarding structural fireproofing to be drawn particularly from the Parker Building fire, but embody practically all the latest ideas in this field.

"In buildings of mercantile, manufacturing or storage occupancy, it is absolutely essential that all vertical openings be thoroughly enclosed in *substantial* fireproof shafts having standard fire doors at all openings or so arranged that the shaft is without openings directly into the various stories. Unprotected vertical openings through buildings are the greatest factor in the loss of life and property by fire and the proper safeguarding of this hazard demands the most careful attention of all concerned.

"The height of fireproof buildings of mercantile, manufacturing or storage occupancy should be limited to correspond to the degree of protection the Building Equipment and the Fire Department is able to furnish. In other words, if adequate fire protection in any building is not available above a certain height, the building should be limited to such height.

"Buildings of large unbroken floor areas filled with combustible contents develop the severest fires and constitute one of the most dangerous sources of general conflagration. Floor areas in buildings of this character should be subdivided by substantial brick fire walls sufficient to form a positive barrier to the spread of fire.

"Fireproof buildings, no matter how well designed and constructed, do not prevent the destruction by fire of contents in any story; and it is essential that high buildings of mercantile, manufacturing or storage occupancy be thoroughly protected by a standard equipment of automatic sprinklers.

"Exterior openings in buildings should

be thoroughly protected against exposing fires. Universal efficient fire protection of exterior openings will practically eliminate the danger of conflagration in cities.

"High buildings of mercantile, manufacturing or storage occupancy should be provided with large, properly enclosed stairways in sufficient number to afford safe exit at time of fire. Such buildings should also be provided with outside fire escape and standpipe equipments.

"Buildings of mercantile, manufacturing or storage occupancy should be provided with adequate systems of inside standpipes equipped with linen hose and nozzles suitable for fire department use, and, in addition, a smaller linen hose and nozzle suitable and safe for the use of occupants. These equipments should be accessible and in sufficient number to effectively cover all portions of the building. They should extend through all stories and should be supplied from a reliable source of water under adequate pressure, in addition, to siamese steamer connections on the outside at street level.

"The use of perforated pipe systems should be prohibited, as such systems are unreliable, inefficient and liable to result in water damages wholly disproportionate to the extent of fire. Where it is desirable to protect only a part of a building, a system of automatic sprinklers with adequate water supply should be employed and the portions protected plainly marked at the siamese steamer connections on the outside of the building.

"Cast-iron columns should not be used in high buildings, as their failure is usually complete and and results in sudden total collapse of the sections supported. Girders and beams cannot be rigidly attached to such columns and defects in the material cannot be easily detected.

"It is essential that all structural members of fireproof buildings be protected by a sufficient mass of fireproofing to thoroughly insulate them against the heat which would be developed by the rapid burning of all materials permitted in any story of such buildings. It is also essential that all fireproofing be firmly anchored, or otherwise securely held in position, where it is of such a nature or so designed that it will become loose as a result of heat. On account of their great importance structurally, columns should be insulated by at least four inches of fireproofing; and no pipes or conduits should be placed in or back of the fireproofing material. On account of the heavy mass of fireproofing with which girders and floor beams are in contact, a lesser amount of protection can be safely employed at the soffits. Generally this should not be less than two inches for girders and one and one-half inches for floor beams.

"All floor arches should be provided with a large factor of safety so as to safely carry the imposed loads, not only under ordinary conditions, but when severely exposed by fire.

"Arches of all forms in common use are seriously damaged when directly exposed to high temperatures of long duration. In buildings containing large quantities of combustible material, they should be so designed or protected against fire that serious structural damage will be prevented.

"No wood or other combustible material should be employed in the construction of fireproof partitions and all metal supports or reinforcements should be thoroughly insulated from heat. Fireproof doors and wired glass in standard metal frames should be used at necessary openings in corridor and room partitions. Provision for expansion in the material used and in metal supports entering into the construction of fireproof partitions is essential, particularly where hollow terra cotta blocks are employed. All fireproof partitions should rest on solid incombustible material.

"In buildings of fireproof construction all floor surfaces, doors, window frames, sash and other trim and finish should be of incombustible material.

"The support of heavy safes and machinery on wood floors and wood skids in fireproof buildings is a menace to both life and property, and should be absolutely prohibited. Heavy shafting should be attached to ceilings in such a manner that it will not fall as a result of fire."

THE NEW BRITISH PATENT LAW.

A REPLY TO FOREIGN CRITICISM OF THE COMPULSORY WORKING CLAUSE.

Engineering.

AS might have been expected, a great deal of criticism is being directed against the new British Patents Act, and particularly against the "compulsory working" clause, which renders liable to revocation patents for inventions which, after a certain period, are found to be worked exclusively or mainly outside the United Kingdom. On the Continent, and, within the last few weeks, in the United States, this clause is attacked as unfair and as virtually a subterfuge to obtain Protection under the guise of Free Trade. An interesting editorial refutation of these charges is contained in *Engineering* for May 8, from which we quote at length below.

"That an outcry would be raised abroad against the new patent legislation was only to be expected. It is merely human nature that those who have been able to make a preserve of the British market for years should send up a wail of indignation on finding that they can no longer take advantage of a law which was framed with a totally different object. Such an attitude is unreasonable, of course, but it is not unnatural. When, however, these same people proceed to tax us with unfair commercial dealing, and accuse the Government of making a change in the Patent Law an opportunity of indulging Protectionist tendencies, they overstep the mark; such a distortion of the facts calls for refutation. What are the true facts?

"For upwards of a quarter of a century Great Britain has been exposed to attacks on her industrial life through the abuse by foreigners of her Patent Laws. To put the case briefly, British patents have in numberless instances been obtained by foreign manufacturers and used simply as cover for the importation into England of goods made abroad under the corresponding foreign patent; or, perhaps, not even under any patent at all. As the result of this practice, the British nation has suffered a three-fold injury. It has been made to pay long prices for the patented article imported from abroad; it has been deprived of the advantage of participating in the manufacture of the patented article whilst the patent existed; and, finally, when the patent expired, it has been placed under the disability of lacking the practical knowledge and experience essential to enable it to start and carry on the manufacture in the teeth of foreign competition. If proof be needed that this was, not only in a moral, but also in a strictly legal sense, an abuse of the privileges of a British patent, it is only necessary to refer to the famous passage in Darcy *v.* Allin, which has always been regarded as an accurate statement of the legal and economic basis of our patent system:—'Where any man, by his own charge and industry, or by his own wit or invention, doth bring any new trade into the realm, or any engine tending to the furtherance of a trade that never was used before, and that for the good of the realm, in such cases the King may grant to him a monopoly patent for some reasonable time, until the subjects may learn the same, in consideration of the good that he doth bring by his invention to the commonwealth, otherwise not.' Subsequent legislation, whilst clearly marking out the bounds of legal monopolies, in no way relieved the patentee of the obligations cast upon him by the common law.

"So long as British patents were granted solely to British subjects, the necessity for enforcing the conditions of working did not arise. If the invention was worked at all, it was naturally worked in England. But when, at the beginning of the nineteenth century, our Patent Office was thrown open to foreigners, the position was altered, and the enforcement of this condition became (if only it had been realised at the time) a matter of vital importance. Unfortunately, the need for insisting upon its observance did not make itself felt at once. The foreigner, however, was not slow to take advantage of this indul-

gence, and it was not long before the British public awoke to find their patent system utilised, not for the purpose of planting new industries on British soil, but for the diametrically opposite purpose of fostering foreign industries to the detriment of British trade. That no serious effort was made, when this abuse was first realised, to bring the foreigner to a right sense of his duties as a British patentee, is remarkable. There is good ground for believing that, had a concerted and well-directed effort been made, say, by one of our Chambers of Commerce, means could have been found, either through the medium of the Courts or the Privy Council, and without the need for further legislation, of compelling the foreigner to work his invention in the United Kingdom in accordance with the conditions of his patent. As it was, however, the very existence of this particular condition seems to have been all but forgotten; at any rate, the power to enforce it had, by long neglect, become, so to speak, atrophied. The more formal and pressing obligation of the patentee—viz., the requirement that he should publish his invention by lodging a specification—appears to have overshadowed, even to the point of total eclipse, the far more important duty of establishing the invention as a new manufacture within the realm, and instructing the community in its use. Anyhow, whatever the explanation may be, the fact remains that no such effort was made.

"The provision, introduced by the Patents Acts of 1883, for obtaining compulsory licenses from defaulting patentees fell far short, even in theory, of what the public had a perfect right to require from the patentee; and in practice it proved hopelessly ineffectual as a remedy for the existing abuse. The attempt to cure the evil by means of compulsory licenses was fundamentally wrong, and proceeded from an inadequate diagnosis of the case. A compulsory license throws the burden of proving the necessity for working the invention in this country upon the petitioner, whereas it is upon the patentee that the duty should lie of absolving himself from this requirement, and of showing that such necessity does not exist. What was wanted was the strict enforcement of this primary obligation, in the absence of reasonable grounds for its remission.

"This is now effected by the 'compulsory working' clause of the new Patents Act. Though popularly regarded as an innovation of a somewhat radical nature, this provision is, as has been shown elsewhere, nothing more than a tardy insistence by dint of statute, upon the performance of an obligation which the common law has always—at least in theory—attached to the grant of letters patent.

"It is also to be observed that this very condition, which has caused such a general outcry on the Continent, is merely the analogue of a clause that appears prominently in the patent code of almost every one of our rivals in commerce. The Americans, it is true, have no compulsory working clause. But the case of America is in every way exceptional Occupying, as it does, a position of splendid isolation, and fenced round with tariff walls sufficiently lofty to keep outside all articles which it may seem more desirable to manufacture at home, America has nothing to fear from the relaxation of this obligation. The patentee must needs work his invention on American soil if it is to be used in that country at all.

"This provision of our Patents Act is not only justified, therefore, by the traditions of our own patent system, but also by the practice of the very people who presume to criticise it.

"So much, then, for the taunt of unfair dealing; the answer to the charge of harbouring 'Protectionist tendencies' may be given more briefly.

"Foreigners have no right to dictate to this country what its fiscal policy shall be; and whether the present Government is true to its avowed principles of Free Trade, or not, is simply a matter for its supporters. At the same time, to be bound hand and foot by foreign-owned British patents, and compelled to buy from Germany or France, or elsewhere, according as the patentee dictates, goods which could, and should, have been manufactured in England under the

British patents, is a condition of things as far remote from the ideal of Free Trade as can well be imagined. It is an approach in the direction of Free Trade, and not a recession from it, to insist that Great Britain shall no longer be a close market to one or another foreign manufacturer, but that the importation of foreign goods shall henceforward compete on equal terms with similar goods manufactured in this country. It is a perversion of language to characterise as a step in the direction of Protection a piece of legislation the tendency of which is to break down oppressive patent monopolies and throw the manufacture open to the public unless the patentee consents to comply with the conditions upon which alone his patent was granted."

THE ECONOMICS OF WOOD PRESERVATION.

THE COSTS AND RESULTS OF THE PRESERVATIVE TREATMENT OF TIE TIMBER.

Eugene P. Schoch—Southwestern Electrical and Gas Association.

A VERY interesting and comprehensive paper on the present practice and economics of wood preservation, presented by Mr. Eugene P. Schoch at the recent convention of the Southwestern Electrical and Gas Association, is abstracted in the *Electric Railway Review* for May 9. Notwithstanding the great attention which is being paid to this subject, a broad, general, comparative discussion of the various methods in use and their economic results is seldom met with and Mr. Schoch's data on actual costs and results, which we present below, are of the highest interest and value. Mr. Schoch is concerned mainly with the results obtained in the preservation of railway ties. We are glad to be able to announce that a similar economic discussion of the value of the preservative treatment of structural timber will be contributed to a future number of THE ENGINEERING MAGAZINE by Mr. Carl G. Crawford, of the Bureau of Wood Preservation of the Department of Agriculture.

The causes of decay of timber are bacteria and fungi which attack the fibers of the wood. These grow best where they have an abundant supply of food and certain conditions of heat, moisture and air. The aim of timber treatment should be, therefore, as much the prevention of these conditions as the poisoning of the organisms. Proper seasoning by air or furnace drying is the most essential first step in the preservation of timber, not only on account of its removal from the interior of the wood of the food on which the destructive organisms thrive, but also because preservative liquids cannot be injected into the wood until space is made for them by the removal of the sap.

"If through proper seasoning the interior of the timber has been rendered practically free of conditions for the development of bacteria and fungi, all future attack becomes possible only through the entrance of moisture from without. If, then, the moisture entering the wood is thoroughly saturated with poisonous substances which inhibit the growth of bacteria and fungi decay is effectively prevented. This is the basal idea of the preservative treatment. Many substances have been used as antiseptics for this purpose. At present there are four distinct kinds of substances used as wood preservers. First of all, coal tar distillates—creosote; second, poisonous salts of metals—zinc chloride, corrosive sublimate; third, crude oil; and fourth, wood tar distillates. These substances are far from being equally successful. They are mentioned here merely as the substances that are actually thought of today as possible preservatives. In some processes combinations of several of these substances are used. The American Railway Engineering and Maintenance of Way Association, in the proceedings of the fifth annual convention, states that the following processes have stood the test of time: Creosoting, zinc chloride with cresote, zinc chloride alone and zinc chloride with glue and tannin. The latter are added merely to fix the zinc chloride

in the wood and prevent its being washed out. Corrosive sublimate also has been used and has proven itself very efficient, but its extremely poisonous effect upon high organisms makes it an objectionable substance. These substances are essentially antiseptics; that is, water that has come in contact with these substances inhibits the growth of bacteria and fungi.

"The third class of substances, mineral oil or crude oil, has recently been thought of as a wood preserver, and a few experimental trials have been made. A record of results published by the American Railway Engineering and Maintenance of Way Association, shows that crude oil does not effectively preserve wood except when used in sufficiently large quantities to exclude moisture from the wood.

"The fourth class of wood preserving substances, distillates of wood tar, might be expected to be just as efficient as distillates of coal tar. Such is far from being the case. They have been offered to the public for many years, but they do not appear to have come into any extended use."

The tar oil distillates hold the highest rank among the admittedly good preservatives. There is no question as to the efficiency of the complex mixture of tar oils known as creasote but all of the component parts of creosote are not of equal value. The general conclusions reached in several independent investigations on this point are:

"(1) That the tar acids, such as carbolic acid, which formerly were considered to be the most valuable constituents of creosote, are soon lost, either washed out or evaporated from the wood, and hence do not serve permanently to preserve the wood. (2) Naphthalene and the low boiling oils are markedly evaporated from the wood during the early years of exposure. (3) The high boiling tar oils, notably the portions boiling from 270 degrees and upwards, are the substances that permanently remain in the wood. All investigators agree that these high boiling oils are the most valuable portions of creosote."

The preservative action of zinc chloride and corrosive sublimate is due to their germicidal power. Moisture entering wood impregnated with these salts forms with them a germicidal solution in which it is impossible for bacteria and fungi to live. Creosote, in addition to a strongly germicidal action, has the power of absolutely excluding moisture, if used in sufficiently large quantities. If a high quality of creosote is used, the high-boiling oils, besides forming strongly germicidal solutions with any moisture which happens to enter, are not readily volatile and are permanent in their effect. The difficulty with the zinc and mercury salts is that, on account of their solubility, they are readily washed out of the wood.

"It is unfortunate that the life of timber in its natural state and as treated by different preservatives cannot be definitely given, because so many factors enter into the determination of its life. There is first of all the kind of wood, the season in which it is cut, the extent of seasoning or drying, and all the other special points which have been called the 'idiosyncrasies' of timber. Above all, the local climatic conditions determine the life of timber, or of timber treated with different preservatives. However if we bar unusually favorable or unfavorable local climatic conditions, and remember that individual pieces of timber may show results differing considerably from the averages, then the following few statements based on a large number of observations may be ventured. Life of white oak and cedar ties, untreated, 10 years; inferior woods, such as tamarack, loblolly pine, etc., 4 to 5 years. Inferior wood ties treated as follows: Burnettizing 12 years; creosoting, very light treatment, about 4 to 5 pounds per cubic foot, 16 years; 12 pounds creosoting, 20 years; 18 or more pounds creosote, 25 to 30 years. In addition the following, found by the railroads of the United States, may be considered as particularly reliable: Pine ties treated with zinc chloride, east of the Mississippi, 10 2-3 years; west of the Mississippi, 11 2-3 years; treated with creosote, even with light treatment, the life is greater than with zinc chloride. Reference has already been made to the fact that wood tar

distillates and crude oil used in moderate quantities have not increased the life of timber to a satisfactory degree.

"Considering next the quantity of preservative used and the cost of the operation, I may offer the following as general averages obtained in the operation of the large 'pressure' plants and as actual cost conditions, to which a reasonble amount of profit must be added before a commercial price can be arrived at. Cost of Burnettizing, 5 cents per cubic foot, or 15 cents per tie of 3 cubic feet. Cost of Wellhouse zinc tannin process, 6 cents per cubic foot, or 18 cents per tie. Cost of the zinc chloride-creosote process, 9 cents per cubic foot, or 27 cents per tie. Creosoting, light treatment, enough for 16 years life, 10 cents per cubic foot, or 30 cents per tie. Twelve pounds creosote, 18 cents per cubic foot, or 55 cents per tie. Heavy treatment, enough for 30 years, 28 cents per cubic foot, or 85 cents per tie. The operating cost of large pressure plants is from 5 to 8 cents per cubic foot of timber. The efficiency of the pressure treatment using a sufficient quantity of a good creosote is beyond question and needs no further comment. In some cases, for instance piles for marine exposure, nothing else will answer. It appears to be the conclusion of the railroads that pressure treatment is the most efficient. Doubtless this is partly due to the fact that they own and operate their own plants and operate on a large scale. The high price of creosote led the railroads to try zinc chloride extensively. The substance is comparatively readily washed out of the wood, so that its use in moist regions is inadvisable. In dry regions it appeared to be serviceable, particularly because the ties are destroyed by wear and tear in about 10 years, and zinc chloride is able to prevent decay for this length of time. Since the introduction of tieplates and of the Rueping process, which uses only small quantities of creosote, the tendency is to abandon zinc chloride treatment. The use of zinc chloride for poles gives little promise of success, because the salt is so readily washed out.

"Purchasers of treated timber are confronted with the same difficulties in a sense that they are confronted with in buying a commercial brand of wood preserver In the first place, the word 'treated' is entirely too vague—the details of treatment must be specified. In good pressure treatment the following amounts are injected: Zinc chloride, from ¼ to 1 pound per cubic foot of timber; creosote, from 5 to 15 pounds per cubic foot (the latter is the maximum that should be asked for for land exposure). The zinc-creosote process treats first with 12 pounds of 2 per cent zinc chloride solution per cubic foot, then allows the timber to dry for 10 days, and subsequently injects 3 pounds of creosote per cubic foot. With the stipulation of the amount of injection should go the specification for the kind of creosote.

"The railroads have come to the conclusion that it is profitable to use the best creosote only. Their standard specification for coal tar creosote runs as follows: Specific gravity at 38 degrees C., 1.03; no distillate below 200 degrees C.; up to 210 degrees not more than 5 per cent; up to 235 degrees not more than 25 per cent; residue beyond 355 degrees, if it exceeds 5 per cent in quantity, must be soft.

"Purchasers should insist on being furnished with the statement of the tests on the creosote with which the wood is said to be treated. But even with all the specific statements as to quantity and quality of the creosote which has been injected, fraud is possible and has been practiced. Professor Alleman of the United States forest service states that of 12 specimens cut from a consignment of piling guaranteed to contain 16 pounds of oil to the cubic foot of timber, some contained less than 3 pounds and none over 7 pounds. The writer has examined many samples of creosote in the market, and has met some samples which would be little better than crude oil or wood tar distillates—they are nothing but low boiling oils with tar dissolved or suspended in them. The purchaser should take sample borings from the shipment and have them analyzed by a competent chemist to determine the quantity and quality of the creosote or zinc present."

APPRENTICESHIP IN FRANCE.

A DISCUSSION OF THE CAUSES OF ITS DECLINE AND POSSIBLE REMEDIES.

Paul Besson—Société des Ingenieurs Civils de France.

ACCORDING to a recent paper presented by M. Paul Besson before the Société des Ingenieurs Civils de France and published in the *Mémoires* for February, the apprenticeship problem, while of considerable importance in all industrial countries, has reached a much more acute stage in France than elsewhere. On account of the dearth of skilled workmen, many French industries, especially that large and most important class which depends on a superior quality of craftsmanship, have reached a veritable crisis. The causes which make for the decline of apprenticeship have been much stronger in France than in any other country and no remedies have been adopted to deal with these conditions. The country is now paying dearly for neglect of so vitally important a problem, and only strong and immediate measures can retain for France her pre-eminence in those special industries in which she has for so long been unrivalled or ensure a satisfactory progress in other fields. M. Besson's estimate of the causes of the decline of apprenticeship and the possible remedies is most interesting and we outline it briefly in the following abstract of his paper.

The principal cause he considers to be a moral one, inherent in the manners, customs and aspirations of the French people. On this point he quotes Le Bon's "Psychologie de l'Education" with full approbation: "The principal reason which causes the people of France to shun manual labor and everything which resembles it is not so much the effort which it demands as the contempt which it inspires. Among all the Latin peoples, the lowest clerk, the humblest public officer, the most modest teacher, consider themselves to be of a class immensely superior to that of the tradesman or artisan, although the earnings of the latter are larger and their work requires a much higher order of intelligence. The result is that most parents of the lower ranks aim to place their sons in what they consider to be the superior class." M. Besson quotes also from the writings of an eminent educationalist, M. Keller: "The workman of today does not wish his son to work with his hands, but prefers to make of him an ill-paid clerk. In the country districts, the small farmers do not wish their sons to cultivate the soil, but seek to place them in some public office. The condition amounts in reality to a disease, and one so prevalent, that France is forced to import her artisans, laborers and farmers from Italy and Belgium."

Closely allied with this attitude of mind of the laboring classes is an economic cause which has much to do with the decline of apprenticeship. The growing desire for ease and comfort impels parents to demand that each child should begin, at the earliest possible moment, to make contributions to the family purse. The education of the child ceases as soon as he has reached the legal age and he is placed in a business house or public office where he works for a mere pittance. Apprenticeship in a trade is never considered, since, in addition to the loss of social prestige, the beginner usually receives no compensation for his labor beyond the instruction given him. In this regard the employers are not blameless. Instead of encouraging apprenticeship, they offer very few inducements to young men and in a large number of cases they positively discourage apprentices. The employers wish for skilled labor and when it is not to be had they make every effort to improve on their machinery rather than teach the trade to young men. This attitude on the part of the employers has a strongly deterrent influence on boys who might otherwise become apprentices. There seems to be a very general fear that the apprentice will serve his time only to find that the trade he has been learning has disappeared.

Legislative blunders also have had much to do with the establishment of the present conditions. Apprenticeship

is still regulated by a statute passed in 1851 and the elastic nature of this law has been responsible, to a large extent, for the disrepute into which the system has fallen. By its provisions apprenticeship could be entered into by a written contract, a verbal contract or no contract at all. Unquestionably it was the expectation of the framers of the statute that by far the larger number of apprenticeship agreements would be put in writing, but the actual result has been that in Paris, since 1860, less than 25 per cent. of such contracts have been so expressed. Verbal contracts are taken seriously by neither party to them and the feeling of irresponsibility on both sides deprives both employer and employed of all the benefits which the system might otherwise confer.

Subsequent legislation, in 1874, 1892, and 1899, was devoted to the regulation of the hours of child labor and, in the main, its aims and results have been satisfactory. In 1900, however, a law was passed in modification of the law of 1892 establishing a maximum day of ten hours for workers of both sexes under eighteen years of age and in addition fixing ten hours as the maximum day for all adults working in establishments where women and children are employed. This astonishing provision, which prevents overtime in any shop where apprentices under eighteen are employed, has practically completed the destruction of the apprenticeship system. Both workers and employers are united to discourage a system accompanied by such unfair restrictions.

Technical and trade schools, M. Besson says, are proposed as a remedy for present conditions, but no school instruction, no matter how competent and thorough, can take the place of the teaching of actual shop and factory experience. He quotes the opinions of many authorities in support of this view. The moral and economic causes of the decline of apprenticeship, he fears, can be removed only by a complete alteration of the habits and aspirations of the people. He reviews the proposals put forward by various bodies, but finds in most of them too great an inclination to regulate apprenticeship by hard and fast legislative enactments. On account of the peculiar nature of the French temperament, a law making the instruction of young workmen obligatory on their employers could never be enforced. The only possible means of restoring the apprenticeship system to its rightful position lies in bringing home to the employers of labor the great importance of the problem, with the removal of the present legislation as a necessary first step. The written contract should be made obligatory and all legitimate means should be taken to stimulate a healthy rivalry among apprentices. The solution of the problem, however, can never be arrived at by legislation, but it must be found by the employers themselves.

UNSOLVED PROBLEMS IN METAL MINING.

A PART OF THE SIXTEENTH JAMES FORREST LECTURE DEALING WITH DRILLS AND DRILLING.

Henry Louis—Institution of Civil Engineers.

A PAPER covering the broad subject of the unsolved problems of metal mining in so comprehensive a manner as that read by Prof. Henry Louis on April 27, as the sixteenth James Forrest Lecture before the Institution of Civil Engineers, does not lend itself to compression into the limits of a short review. Prof. Louis treated his subject under the various heads of prospecting, the opening up of deposits, their actual exploitation, the transportation of ore to the surface of the earth, the dressing and preparation of the crude material for use in the smelter, and, finally, the question of safety in metal mining. The numerous problems still unsolved under each of these divisions were discussed with a wealth of historical and technical detail which we cannot hope to reproduce. The following extracts, therefore, are limited only to Prof. Louis' comments on machine drills and drilling, subjects which are

attracting considerable attention at the present time.

"The first practical rock-drill for hard rock, a pneumatic percussive drill, was designed, not for mining, but for tunnelling purposes, by Sommeiller for the Mont Cenis tunnel; priority of conception seems to belong to an American, Fowle, who patented such a drill in 1851, and an Englishman, Bartlett, in 1855; but the Sommeiller machine, designed in 1857, was the first to be actually used, in 1861; it seems to have been first applied to mining at Moresnet, in Belgium, in 1863. The early machines were clumsy and inefficient, but improvements came apace, so that in 1875 there were already several patterns doing satisfactory work; about this time we find them in use for driving the St. Gothard and the Arlberg tunnels, and in the former careful experiments showed that the newer drills were working three times as fast as the older Sommeiller drill. All these machines were of what is now known as the 'piston-drill' type, in which the drill steel is firmly secured to the piston-rod, in contradistinction to 'hammer-drills,' in which the piston-rod strikes as a hammer might, upon the butt end of the drill steel. The former type answers perfectly in open workings, shafts, levels, and other places in which there is a fair amount of room to enable it to be set up and worked. Of recent years, however, a demand has sprung up for a lighter form of machine drill, that can be used in confined spaces and awkward corners, such as the working-places or stopes of most mines present, the essential qualifications for a stoping-drill being portability, compactness, and ease of handling, so as not to be too much for one man to work alone. The Western States of America appear to have led the way ten or fifteen years ago in the use of machine-drills for stoping, but it was not long after that the need of such a machine began to make itself urgently felt in the gold-mines of the Witwatersrand, where the cramped conditions of the stopes, owing to the narrowness of many of the reefs, and their flat dips, render the problem one of exceptional difficulty. The shortage of labour that attended the reopening of the mines after the Boer War accentuated the need, the gravity of which is evidenced by the fact that the Transvaal Government, in co-operation with the Transvaal Chamber of Mines, is offering two prizes of 4000*l.* and 1000*l.* respectively for the best rock-drill suitable for narrow stoping work under the working conditions that obtain on the Witwatersrand. It will be remembered that a preliminary competition of this kind was held in Johannesburg in January last, at the instance of the *South African Mines* newspaper. Nine drills were entered for this contest, five being small drills of the piston-drill type, whilst the other four were hammer-drills. Here I need only say that the first place in the competition was taken by a hammer-drill, the final opinion of the judge, Professor Orr, being expressed as follows:—'One is forced to the conclusion that for lightness combined with drilling capacity the hammer type is essential.'

"The first hammer-drill that I know of is the Francke drill, used about 1890 in the copper-mines of Mansfield. This was a small and extremely light drill, weighing only some 16 pounds, was held in the hand, and was run at the very high speed of over 8000 blows per minute. This particular machine does not seem to have been altogether successful, but it was not long before other drills, which were practically adaptations of the pneumatic caulking-tool, etc., were introduced.

"It is obvious that a hammer-drill, in which the drill steel is not attached to the piston, admits of being run at a far higher speed than a piston-drill, and can therefore be made equally efficient with the latter, though having a shorter stroke, thus enabling the whole machine to be made much lighter and more easy to handle in a confined space. I do not, of course, wish to suggest that the result of the above test, carried on, as it necessarily was, under competitive conditions, can be looked upon as anything more than an indication, but it tends to show that in the future a special type of drill, not merely an ordinary drill upon a reduced scale, will have to be devised for stoping and breaking out ore, as distinct from sinking or driving.

"The great drawback shared by all forms of pneumatic drills is their excessive power consumption. Careful tests in South Africa have shown that an ordinary rock-drill only develops 1.7 horse-power against a face of rock, whilst the drill-cylinder indicates about 5 horse-power, and at the same time it requires as much as 28 horse-power at the compressor-engine to work it, the heavy compression losses and pipe-line losses being almost inevitable. Electric transmission of power, which has been of such immense value in most departments of mining, has hitherto been unsuccessful when applied to percussive rock-drills, the steady torque produced by the electric current not being readily adaptable to the reciprocating action required for percussive drilling. A number of electrically-driven percussive drills have been devised, but it cannot be said that any one of them has yet shown itself capable of competing with the pneumatic drill under the strenuous conditions of actual mining work. The best prospect of success up to the present is, in my opinion, afforded by the Temple drill, in which a small electric motor works a pulsator, which sends puffs of compressed air alternately into either end of the cylinder of what is practically a valveless pneumatic rock-drill. The machine is too new to enable any definite statements to be made about it; it has the advantage of small power consumption, a 5-horse-power motor working it; but, on the other hand, the necessity of having the two machines, the pulsator and the drill itself, at the working face is a decided drawback.

"My own impression is that the ultimate solution of the drilling problem will be found in the adoption of an electrically-driven rotating drill. The advantages of such a drill in rock soft enough to admit of its use under present conditions are sufficiently obvious. For example, electrically-driven twist-drills are doing excellent work in the comparatively soft ore of the Cleveland ironstone mines, and I have already mentioned how completely the rotating hand-machine of the coal-miner has displaced the percussion jumper. The success of the hydraulically-driven rotary Brandt drill in the Simplon Tunnel will be fresh in the memories of many here; the same drill has also done good work in several mines where the workings are large enough to enable a 3-inch borehole to be used with advantage. This drill works under heavy hydraulic pressure (700 pounds to 2000 pounds per square inch), but its rate of rotation is slow, being only three to ten revolutions per minute.

"An electrically-driven drill will necessarily have to rotate at a relatively high speed, and it seems safe to predict that such machine will come into use as soon as a suitable material for the cutting edge of the drill shall be discovered; here again we need a metal distinctly harder than quartz at least, and strong enough to resist the severe torsional strains to which it will be exposed. I am a very strong advocate of rotary drilling, not only because I consider it as mechanically the better system, but because I hold that it will afford the most complete solution of the dust problem. It is now fairly well established that that dread disease, miners' phthisis, the greatest danger to health to which the worker underground is exposed, is largely due to the inhalation of the fine sharp-edged particles of mineral thrown off by the action of the percussive drill. Something has been done to combat this danger of late years, notably by the use of jets or sprays of water, and particularly by the use of hollow drill steels, through which a stream of water can be carried to the very face of the drill-hole, but I am inclined to think that it is only by rotary boring, of course with the aid of water, that this deadly enemy can be finally conquered.

"I may add that the argument, occasionally put forward in favour of the pneumatic drill, that it helps to ventilate a close end, has, in my opinion, very little weight, because it is obviously easy to produce any desired amount of ventilation by means of small electrically-driven fans, which will give a continuous air-current, whereas the drill does not supply any air at the times when this is most needed—that is to say, after shots have been fired, and whilst the men are doing their hardest manual work—namely, setting up the drill."

THE UTILIZATION OF BLAST FURNACE SLAG.

A REVIEW OF METHODS FOR THE MANUFACTURE OF SLAG BRICKS AND CEMENT.

The Chevalier C. de Schwarz—Iron and Steel Institute.

AN interesting paper on the utilization of blast-furnace slag for the manufacture of bricks and cement was presented by the Chevalier C. de Schwarz at the recent meeting of the Iron and Steel Institute. A particularly important point in this paper is the demonstration which M. de Schwarz gives of the incorrectness of the belief held by many writers on the subject, that no cement can be made from the slag produced in the manufacture of white pig iron. In the brief abstract of the paper which is given below, M. de Schwarz's comments on this point are given in full.

The first process for the utilization of blast-furnace slag was patented in 1728 by an Englishman, John Lane. He succeeded in making large solid blocks of artificial stone for use in river and canal embankments, by working liquid slag thoroughly to expel air or gas bubbles, adding a quantity of sand or crushed slag, and compressing the resulting doughy mass in cast iron moulds. The utility of his process was limited, however, by the fact that it could be applied successfully only to slags high in silica and poor in iron.

Considerably later the hydraulic properties of granulated basic slag were recognized by Fritz Lürmann, who made bricks by mixing granulated slag with lime cream and pressing the mixture into moulds. The lime combined with the free silica of the slag to form a cement and the bricks hardened on exposure to the air in six to eight weeks. This primitive method, however, produced bricks of only very moderate strength and many improvements have been necessary to bring the slag-brick industry to its present importance. Chief among these may be mentioned the introduction of appliances for the automatic feeding and mixing of proper quantities of materials, of power presses capable of applying a gradually increasing pressure, and, lastly, of ball mills for the fine crushing of slag and lime. Plants embodying these improvements produce, per press, about 2,000 8-pound bricks per hour at a cost of about 8 shillings per thousand. To drive each press and its auxiliaries requires about 25 horse power. Bricks made by this method have a crushing strength of 1,700 pounds per square inch. Recently, improved machinery invented by Paul Thomann in Germany has considerably cheapened the cost and improved the quality of bricks manufactured by this method.

Another process, too expensive for any purpose other than making artificial stones of special size, consists of compressing in moulds a mixture of one part of Portland cement with four to five parts of granulated slag. The best slag bricks are manufactured according to the English method, in which no binding medium, such as cement or slaked lime, is used. It is based on the fact that insoluble silica is rendered soluble by exposure to high steam pressure for a certain time. Bricks of excellent shape and great strength, are produced by this method at a cost of 13s. per thousand.

"Slag bricks have the following advantages over ordinary baked clay bricks:—(*a*) They have a considerably higher resistance against crushing; (*b*) houses built with slag bricks are never damp, and can be occupied without danger to health as soon as they are built; (*c*) slag bricks are more accurate in shape and dimensions, because they are not baked, and therefore do not shrink like clay bricks.

"For certain purposes slag bricks, manufactured according to the English process, are, on account of their accurate shape and extreme hardness, preferred even to natural stone; for instance, in Brussels such bricks are used for the facing of walls for houses, and paid for at the rate of 60 francs (48s.) a thousand. For ordinary masonry, slag bricks manufactured according to the other methods are used because they are considerably cheaper."

The manufacture of slag cement, however, is of much more importance than

that of bricks or artificial stones and this problem is receiving a great deal of attention. Many erroneous statements are made by writers on the subject. "For instance, it has been repeatedly stated that no cement can be made from slag resulting from the manufacture of white pig-iron. This is incorrect, as may be proved by the fact that Portland cement of good quality can be made from such slag, containing 42 per cent. of lime and 4½ per cent. of oxide of manganese. The cement made from such slag showed not the slightest trace of instability of volume even after six years' use; it also stood all the tests required by the standards for Portland cement. The manganese oxide in the cement gave it a somewhat brownish colour, which, however, was not considered a fault by some customers, but on the contrary was preferred to the ordinary tint for making artificial stones.

"To a certain extent the presence of metal oxides, such as those of iron and manganese, which, as a rule, are higher in slag from white pig-iron, makes the cement made from it more apt to resist the influences of sea water, as already mentioned in previous papers. Secondly, the presence of metallic oxides reduces the temperature of fritting, necessary for the formation of clinker, thus effecting saving in fuel as a consequence. As the majority of blast furnace slag produced nowadays results from white Thomas pig, it may be considered advisable to draw attention to this fact, as hitherto the general belief was that only slag resulting from grey pig can be used for making cement on account of its higher percentage of lime and its small percentage of manganese oxide. It has been proved that a high percentage of lime in Portland cement is not only not necessary, but is to a certain extent even injurious, as, being to a certain extent free, it causes the cement to 'blow.' Therefore such cement, rich in lime, must, as every experienced cement maker knows, be kept for some time in a cement silo before being ready for use, in order to give it time and opportunity to absorb carbonic acid and water from the air for the purpose of converting the free lime it contains into carbonate of lime and into hydrate of lime respectively. Experience has also shown that cement, rich in lime, cannot be used advantageously for buildings in sea water."

M. de Schwarz reviews the more recently invented processes for the manufacture of slag cement, those of Mathesius, Renfert, Canaris, Colloseus, and others, and finds that the Colloseus process is the only one commercially successful. He describes the machinery used in connection with the process and gives the following general details:

"According to this process, solutions of alkaline salts are injected into the hot liquid slag and thus intimately mixed with the latter, the nature and concentration of the injected solutions depending on the chemical composition of the slag, principally on its contents of lime. The quantity of the solution to be injected should be as high as possible; however, the slag thus treated must be perfectly dry after the operation. The salts used for preparing the solutions are principally alum, sulphate of magnesia, and nitrate of lime. The concentration, as a rule, varies from 2 to 5 per cent. of salt to from 95 to 98 per cent. of water.

"On account of the great heat the salts are decomposed, most of the sulphur escaping as sulphurous acid and sulphuretted hydrogen. The slag is chemically and physically changed, and gets the appearance of a porous clinker easily broken up and reduced to powder.

"In case slag with a comparatively high percentage of silica and a lower percentage of lime is to be converted into cement, the concentration of the alkaline solution is raised to a maximum of 10 per cent. of the salt to 90 per cent. of water; besides this a small addition of common cement, clinker rich in lime, has been found beneficial in such cases.

"As to the quality of this cement, it may be said that, according to information received, it has stood all the tests prescribed for Portland cement by English, French, and German authorities. The cement has been employed for about a year in the erection of viaducts, railway embankments, bridges, houses, etc., showing, up to date, not the slightest trace of damage."

THE BY-PRODUCT COKE OVEN IN AMERICA.

A DISCUSSION OF ITS PRESENT STATUS AND PROBABLE FUTURE.

William H. Blauvelt—American Society of Mechanical Engineers.

SINCE the introduction of the by-product coke oven into the United States in 1894, the growth of that branch of the coking industry has been only moderately rapid. According to some figures given by Mr. William H. Blauvelt in his paper before the semi-annual meeting of the American Society of Mechanical Engineers, just closed, in 1897 out of a total production of 13,288,-984 tons of coke, 1.97 per cent. were produced in by-product ovens, and in 1906, 12.52 per cent. out of a total production of 36,401,217 tons. But even this large increase leaves the by-product industry in a position of much less relative importance than it occupies in Europe. A number of reasons can be assigned for its relatively slow growth, among them the cheapness and high quality of coals generally available, the absence of chemical industries, the comparatively small demand for tar for use in the briquetting industry and on roads, and the lack of appreciation of the value of ammonium sulphate as a fertilizer. Mr. Blauvelt, however, considers that the conditions which has retarded its growth in the past are rapidly disappearing and he looks for a much more rapid extension of the use of the by-product oven in the future. The following abstract touches only the main points of his very comprehensive paper.

Coke ovens may be generally divided into two classes, beehive ovens and retort ovens, the various special types of the latter arising from two root forms, the Coppée oven, with a long, narrow coking chamber and vertical side flues, and the Knab-Carvés oven, with a coking chamber of similar form but with horizontal side flues. In the beehive oven the coal is coked in a flat layer about 25 inches thick. The combustion which produces the heat for coking takes place within the coking chamber, above the coal. Air is admitted at the front door and the products of combustion escape through a hole in the roof. The beehive oven as now built in America is about 12 feet in diameter and 6 feet 9 inches high. The usual charge is about 6 tons and the coking process takes from 48 to 72 hours, making the output per oven about 1.5 to 2 tons per day. In the present unstable condition of the iron industry the beehive oven has certain substantial advantages. It is cheap and easy to build and it can be shut down with relatively small loss and started up again with ease. It is unlikely, however, that the beehive oven will long retain its present prominence. The increasing stability of the iron industry will gradually remove its peculiar advantages but a more potent cause in its replacement by the retort oven will be the exhaustion of the coals adapted for use in the beehive type. Many large deposits of coal exist which are not well suited to the beehive open but which can be used with excellent results in ovens of the retort type and in many sections of the country these deposits are the natural sources of supply for important metallurgical works. It is particularly in such cases that the retort oven is coming into prominence.

The retort oven consists essentially of a long, narrow, firebrick chamber, 30 to 40 feet long, 7 to 9 feet high, and 16 to 20 inches wide. The average capacity is about 12 tons per day. In the coking chamber the coal is coked by heat generated by the combustion of gases in flues in the side walls. The essential difference betwen the beehive and retort oven processes is that in the latter air and the products of combustion are carefully excluded from the coking chamber. The retort process, therefore, results in a true distillation of the coal. The gases produced by the two processes differ considerably in composition and in value. In the beehive oven the admission of air reduces the quantity and quality of the tar products and destroys practically all the ammonia. Hence by-product recovery in connection with beehive ovens is no longer practised in the United States. The only representa-

tive of beehive by-product ovens in the country is the Newton Chambers and the plant in which ovens of this type were installed has been closed down for some time.

"The four types of by-product ovens in operation and under construction in the United States are all of the retort type, and have all been developed from the original types of the Coppée or Knab-Carvés designs. Of these there are 11 plants of the Otto-Hoffman and the United Otto type, 13 plants of the Semet-Solvay type, three plants of Rothberg ovens, and one plant, under construction, of Koppers ovens, making a total of 28 plants or 4763 ovens." The United Otto and Koppers ovens are developments of the Coppée, vertical-flue type; the Semet-Solvay and Rothberg ovens, of the Carvés or horizontal-flue type. The distinguishing features of the various ovens have no influence on the coking process. The difference between the types exist, for the most part, in the arrangement of the flue systems, the methods of preheating the air, and the methods of controlling the admission of the air and gas. The operation of the ovens is essentially the same. Coal is charged into the retort chamber through holes in the roof and is coked by the heat produced by the combustion, in flues in the walls and bottom of the chamber, of part of the products of distillation. The products of distillation, carrying the tarry vapors and ammonia, are drawn from the tops of the ovens into a main which extends the length of the battery. The recovery of by-products is optional, depending on market conditions and the quality of the coal coked. In case by-products are to be recovered, the gas is led to a recovery building for treatment. If not, a proper proportion of the gas is returned to the oven flues, where it is burned with a proper admixture of air, and the remainder is available for raising steam. The heat in the waste gases from the flues is utilized for preheating the air supply by regeneration or recuperation or for raising steam for the operation of the plant.

The process of by-product recovery is similar to that in plants for the manufacture of illuminating gas. The gas coming from the main is cooled slowly in large air- or water-cooled vessels, a common form of cooling plant being a series of vertical cylinders containing tubes like a vertical boiler. During this cooling process most of the tarry matter and the water vapor are thrown down, the latter carrying with it a considerable part of the ammonia. The tar remaining in the gas is extracted in a special tar extracter and the gas is then drawn through scrubbers for the separation of the ammonia, benzol and cyanides. In these scrubbers, which may be of either the bubbling or the rotary type, the ammonia is absorbed by water, the benzol by heavy tar or petroleum oils, and the cyanides by an alkaline solution of ferrous sulphate. After this treatment the gas can be returned to the ovens or it can be used as a fuel, in gas engines, or for illumination. When used for the latter purpose, it must be purified of sulphur and it is usual also to omit the removal of the benzol.

Further treatment of the by-products includes the separation of the tar from the ammonia liquor and the distillation of the latter. The tar and ammonia liquor are separated in large tanks by the difference in their specific gravities and the tar is then ready for shipment. The ammonia exists in the liquor in various combinations and its extraction is somewhat complicated. The final product of the distillation may be crude ammonia liquor, pure aqua ammonia, or ammonium sulphate. Benzol is recovered from the heavy oils used to absorb it by heating the oil with steam and condensing the benzol oils driven off to crude benzol. Cyanides are not being recovered in any American plants.

The mechanical problems of a by-product coking plant are numerous. Among the more important may be mentioned the arrangements for coal handling and storage, the crushing and briquetting of the coal, if such treatment is necessary, the charging of the ovens, the drawing and quenching of the coke and its preparation for market, and the operation of the recovery plant. The development of the mechanical appliances about the plant has been one of

the special features of the growth of the by-product oven in America.

"In addition to the various problems in mechanical and chemical engineering presented by the operation of the by-product coke oven, there are a number of metallurgical problems, some of which have been solved with material gain in the efficiency of the coking operation and the yield of by-products; the solution for others is yet to be found. The driving off of the hydrocarbons from coal by distillation is a very complex process. Each change in conditions of the temperature, rate of distillation, etc., gives different results, and on account of the hydrocarbons being so complex in composition, no definite figures can be placed on the operation. Many experiments, for example, have been made to determine the amount of heat absorbed in the coking process per unit of coal coked. Many processes have been devised for converting the major portion of the nitrogen in the coal into ammonia. These and other problems, however, are not much nearer solution than when the by-product process was first introduced into this country. The experience in the retort house of the gas works has shown that high heats and rapid coking increase the volume of gas and tend to break down the heavier hydrocarbons, and the same is doubtless true in a measure in the retort oven, although the much greater bulk of the charge, the different relation between the volume of the gas produced in proportion to the heated surface of the retort, etc., modify these conditions.'"

After an extended consideration of the economic aspects of the problem, Mr. Blauvelt summarizes his conclusions as follows:

"What is to be the development of the by-product oven in this country? Compared with many industries its growth has been slow, but this, as has been pointed out, is largely due to the condition of the chemical industries in this country, which must of necessity keep pace, at least in a measure, with the sources of their raw materials. The capital required in the installation of the by-product oven is relatively large, and the results would have been serious if the rate of oven building had been greatly in excess of the demand for its by-products. In all industries depending upon the by-products of coke a promising future is apparent. The use of gas for illuminating purposes has become firmly established, and the rapid introduction of the gas engine affords a market for fuel gas. But we must look to agriculture as the principal consumer of any largely increased production of ammonia. Through the growing influence of Government and State Experimental Stations and agricultural colleges, science is being applied more and more to agriculture, and this cannot but lead to the general use of artificial fertilizers which naturally follows a higher standard of farm work. As a fertilizer base, sulphate of ammonia, with its nitrogen in the most available form, plays a most important part.

"During the last few years the production of tar has exceeded the demand, so that large quantities have had to be burned as fuel at low prices, but the outlook for this by-product is more favorable than it has been. While it may be some time before the highly specialized chemical industries for the production of anilines and dyes have reached any important growth, yet the prospects for the development of the cruder tar products are encouraging. The rapidly increasing price of lumber is forcing the necessity of creosoting, with the attendant consumption of creosoting oil, onto large lumber users like the railroad companies.

"The practical start in the commercial manufacture of briquettes promises an early development of that industry, and a very modest position as a producer of fuel would mean consumption of a large amount of pitch. If the number of by-product ovens and the output of tar therefrom were doubled, a production of less than 3,000,000 tons of briquettes per annum would consume all the pitch from this increase, without providing for any growth in the important roofing and paving industries, and without providing for any consumption of tar in the new tarred roads. This tonnage of briquettes, compared with the 60,000,000 tons of anthracite which will probably be pro-

duced this year, and the 340,000,000 tons of bituminous coal mined in 1906, suggests that briquetting when once established, even as an 'infant industry,' may soon reach the condition which exists in continental Europe, namely, where its growth would depend only upon the available supply of pitch. Briquetting pitch must always be sold at a moderate price, unless the conditions of our fuel supply change materially. But, as in Europe, when once developed, briquetting will probably be the principal consumer of pitch produced in the United States.

"The by-product oven belongs to the present day. The production of coke at the blast-furnace plant, where the operation is assured by large storage of coal and where the labor is under better control than in less developed regions, is in line with today's manufacturing methods. The higher economy of its operation, its special adaptability to control by the modern scientific organization, the ability to draw coal from several fields, and the successful adaptation of labor-saving appliances to its various operations, all point to its being the oven of the future."

THE GASES OCCLUDED IN STEEL

A REPORT OF THE FIRST OF A SERIES OF INVESTIGATIONS ON THEIR NATURE, DISTRIBUTION AND LIBERATION.

Dr. G. Belloc--Société d'Encouragement pour l'Industrie nationale.

COMMENTING editorially on the industrial importance of the subject of the occlusion of gases by steel and iron, *The Engineer* for May 15 says: "That immersion in a weak solution of acid and water affects the physical properties of steel is, it would seem, beyond doubt; at any rate, such experts as Mr. Stead, Professor Ledebur, Mr. Stromeyer, and others appear to have no doubt about it. How it weakens the metal they are, however, not fully able to explain, and they advance a theory which, up to the present, lacks really substantial verification. This theory is that during immersion hydrogen gas is, under the action of the acid, generated and occluded in the body of the steel itself. This is a hard saying, and a few years ago, before the microscope had revealed the structure of steel, it would have been wholly unbelievable. Even now there are plenty who cannot understand how the acid bath can possibly have more than a superficial effect, and who demand some other explanation of the extraordinary brittleness which has been frequently observed in pickled bars. The problem is further complicated by the fact that very moderate heat treatment is sufficient to expel all the evil which pickling has put into the plates or bars. The Admiralty specifies that all boiler plates and tubes shall be dipped to remove scale, and it does not fear that the boilers will be rendered dangerous by that process, since it is held that at a temperature of 300 degrees F., or so, the occluded hydrogen is driven out, and the metal returns to its normal condition. Other people will not have pickling at any cost, as they believe that permanent injury is caused to the plate thereby. The widest diversity of opinion on the whole subject exists, and it is one of industrial importance that might well be taken up and thoroughly investigated."

An inquiry on the subject has been started in France under the auspices of the Société d'Encouragement pour l'Industrie nationale and in the April number of the *Bulletin*, Dr. G. Belloc, who is in charge of the researches, presents the results of a preliminary series of investigations. Dr. Belloc hopes by his researches to settle the questions of the state in which the gases exist in steel, their distribution, their variation with the processes of manufacture and their effects on the physical and mechanical properties of the steel. For the present the phenomena of pickling have been disregarded. Dr. Belloc's preliminary researches have been based on the theory that it is during the process of cooling that the gases are shut up in the steel. His method has been, therefore to drive out the enclosed gases by

reheating, to capture them and analyse them. It is impossible to give here a description of the highly involved methods of the investigation but a brief outline of the conclusions he has already reached is given in the following abstract of his report.

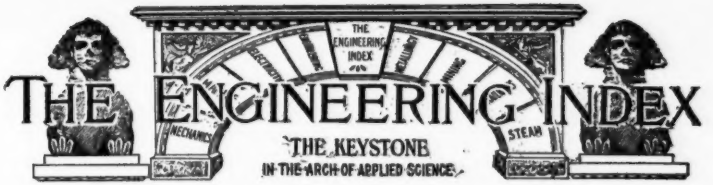
The liberation of the gases has a direct connection with the critical points of iron and from this point of view it may be considered to take place in three main stages. The gases begin to appear at a variable and not well defined temperature between 150 and 400 degrees C. In general, however, there is only a slight liberation while the iron remains in the alpha form, though the amount of gas given off tends to increase with the temperature. At temperatures around 300 degrees the latter general relation between temperature and liberation of gases is subject to slight irregularities. Between 500 and 600 degrees, at the beginning of the transformation of alpha into beta iron, gases are given off in abundance but as the transformation becomes more complete the liberation of the gases diminishes. Another point of abundant liberation occurs, however, with the transformation of the beta into gamma iron. Although the liberation reaches a maximum during the course of that transformation it seems to have a tendency to increase as the temperature rises after the iron has reached the gamma form. The transformation in the condition of the carbon, in a 0.12 per cent. carbon steel, has no apparent influence.

The gases liberated are mixtures of carbon dioxide, carbon monoxide, hydrogen and nitrogen. Carbon dioxide appears first and at the beginning of the action forms practically all of the gas liberated. It disappears at about 550 degrees, either because it has all been driven off or because what remains is reduced by hydrogen. As carbon dioxide ceases to appear the liberation of nitrogen begins. It continues at all temperatures higher than 550 degrees, but in quite small proportions, usually under 10 per cent. Above 400 degrees hydrogen and carbon monoxide form practically all the gas liberated. Their relative proportions are subject to sudden change with changes of temperature and even vary greatly at the same temperature in different specimens. However, these researches lead to the conclusion that the minimum percentage of hydrogen is reached betwen 600 and 700 degrees and that above 800 degrees carbon monoxide predominates, that is when the iron is in the gamma form.

In one of the two bars tested the ratio betwen the total volume of the gases liberated and the volume of the steel was much greater, and the liberation of the gases began at a much lower temperature, than in the other, though the two bars were prepared under the same conditions and were cut from the same ingot. A possible explanation of this phenomena is the fact that the latter bar was turned to size with much lighter cuts than the former; it is possible that the slower turning process resulted in the escape of a larger fraction of the gases from the cold bar. Another possible explanation may be that the amount of gas varies in different parts of the longitudinal section of the ingot. The question is one which requires fuller investigation.

In the bars themselves the gases are very irregularly distributed. In one of the bars tested the total proportion of the gas was much larger in the intermediate portion than in the central or superficial portions. The ratio betwen the hydrogen and the carbon dioxide was equally irregular. It is possible that the distribution of gases in the cross section of the ingot varies according to determinable laws like that of other substances in steel. On this point also further investigation is necessary.

As to the state in which the gases exist in the solid metal, the investigations give no evidence of the existence of a tension of dissociation. The maximum of liberation at the beginning of each change in the state of the iron would suggest the idea that the molecular movements consequent on the transformation act, first of all, as a sort of mechanical agitation, without prejudice to a sudden change in solubility or a variation in the law of solubility.



The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

A Working Method for Masonry Arch Design. William T. Lyle. Explains method. 1200 w. Eng Rec—May 2, 1908. No. 92072.

See also Reinforced Concrete, under BRIDGES.

Bascule.

Bascule Bridge of the Rall Type at Peoria, Ill. Illustrates and describes the general design of this bridge and details and methods of operation. 2000 w. Eng Rec—May 9, 1908. No. 92207.

Columns.

Safe Stresses in Steel Columns. Discussion by William Cain. 1500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92646 E.

Drawbridges.

Raritan River Bridge; New York & Long Branch Railroad. Illustrated detailed description of the construction of this new 28-span plate-girder bridge, with draw-span of 331 ft. 1600 w. R R Gaz—May 8, 1908. No. 92170.

See also Pontoons, under BRIDGES.

We supply copies of these articles. See page 658.

Floors.

Waterproofing Bridge Floors. Considers the requirements and methods. Ills. 1800 w. Ry Age—May 15, 1908. No. 92329.

Masonry.

See Arches, under BRIDGES.

Pontoons.

Pontoon or Floating Draw-bridges. Illustrates and describes types, giving information relating to them. 5000 w. Eng News—April 30, 1908. No. 92012.

Quebec.

The Theory of Latticed Columns, a Comparison of Cantilever Bridge Chords, and a Discussion of the Quebec Bridge Specifications. Appendices 16, 17, 18 and 19, with inset sheet. 11800 w. Eng News—April 30, 1908. No. 92015.

The Fall of the Quebec Bridge (L'Effondrement du Pont de Québec). G. Dupont. Describes the structure and discusses the causes of the catastrophe and the findings of the Commission. Ills. 5000 w. Génie Civil—April 4, 1908. No. 92416 D.

Reinforced Concrete.

A Three-Hinged Reinforced Concrete Arch. Charles W. Comstock. Illustrated description of the design and construction of a bridge in Denver, Colo. 3000 w. Cornell Civ Engr—May, 1908. No. 92603 C.

A Light Three-Hinged Concrete Arch Bridge in Rock Creek Park, Washington, D. C. Illustrated description of a design for a bridge in a thickly wooded gorge, aiming at harmony with surroundings. 1200 w. Eng News—May 21, 1908. No. 92398.

Reinforced Concrete Overgrade Highway Crossings. Photograph, drawings and description of a crossing built by the Vandalia R. R. between Terre Haute, Ind., and Brazil. 800 w. R R Gaz—May 22, 1908. No. 92522.

See also Trestles, under BRIDGES.

Steel.

Quick Replacing of a Double-Track Steel Span. States conditions and gives illustrated description of work. The structure was out of service only 36 minutes. 900 w. Eng Rec—May 9, 1908. No. 92210.

The Erection of the Towanda Bridge. Brief illustrated description of a plate-girder bridge across the Susquehanna River carrying double-tracks of the Lehigh Valley R. R. 2200 w. Eng Rec—May 2, 1908. No. 92069.

Erection of the Bellows Falls Arch Bridge. Discussion by F. W. Skinner giving illustrated descriptions of examples of the principal types of long-span arch erection, with time and cost. 2500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92645 E.

See also Column, Drawbridges, Quebec, and Williamsburg, under BRIDGES.

Trestles.

Concrete Coal Trestle and Ash-Handling Plant. Illustrated description of the D., L. & W. plant at the Hoboken terminal. 900 w. R R Gaz—May 8, 1908. No. 92173.

Viaducts.

See Elevated Railways, under STREET AND ELECTRIC RAILWAYS.

Williamsburg.

Williamsburg Bridge Towers. Brief illustrated description of new construction to strengthen the structure for possible service. 1200 w. Eng Rec—May 23, 1908. No. 92534.

CONSTRUCTION.

Columns.

See same title, under BRIDGES; and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Concrete.

See Foundations, under CONSTRUCTION; Concrete, under MATERIALS OF CONSTRUCTION; Sewers, under MUNICIPAL; Dams, under WATER SUPPLY; and Conduits, under ELECTRICAL ENGINEERING, TRANSMISSION.

Earth Pressures.

Earth Pressures (Sulla Spinta delle Terre). Carlo Parvopassu. A mathematical discussion of the theory of earth pressure. Ills. 3500 w. Serial. 1st part. L'Ing Ferro—April 16, 1908. No. 92425 D.

Earthwork.

Comparative Costs of Earthwork. A P. Davis. Projects carried out in connection with the U. S. Reclamation service are compared. Ills. 4000 w. Eng Rec—May 16, 1908. No. 92308.

Estimates.

The Use and Abuse of Cost Data. W. W. Patch. Shows how misleading cost analyses may prove. 1100 w. Eng News—April 30, 1908. No. 92011.

Fireproofing.

The Parker Building Fire: Report of the New York Board of Fire Underwriters. Abstract of the final and authoritative report. 2500 w. Eng News—May 21, 1908. No. 92500.

Floors.

The Phelan Building Floor Construction. Illustrated detailed description of building details complicated by the irregularity of the lot. 2000 w. Eng Rec—May 2, 1908. No. 92071.

Foundations.

Recent Developments in Pneumatic Foundations for Buildings. Discussion of the paper of D. A. Usina. 2500 w.

We supply copies of these articles. See page 658.

Pro Am Soc of Civ Engrs—May, 1908. No. 92648 E.

Concrete for Foundations of Buildings and Machinery. Henry Adams. Suggestions in regard to its use and the methods employed. 3300 w. Pub Works—April, 1908. No. 92641 B.

Concrete Foundations in Shifting Grounds. Describes conditions and the remedy of the difficulty as worked out at Boomer, W. Va., at a mine plant. Ills. 700 w. Eng News—May 21, 1908. No. 92501.

Difficult Sub-Surface Building Work in Chicago. A 9-story reinforced-concrete warehouse, with a 4-story terminal station for the freight-tunnel system under it, being built on the north bank of the Chicago River, is described. Ills. 3000 w. Eng Rec—May 23, 1908. No. 92533.

See also Piling, and Underpinning, under CONSTRUCTION.

Piling.

United States Steel Sheet Piling. Illustrated description of its use in the foundation for the A. A. Pope building, Cleveland, O. 900 w. Ir Age—May 28, 1908. No. 92649.

Spirally Armored Concrete Piles. Illustrated description of "Considère" piles, and their use. 1200 w. Engr, Lond—May 8, 1908. No. 92360 A.

Reinforced Concrete.

A Reinforced-Concrete Band Stand. W. F. Creighton. Illustrated description of a novel design built at Nashville, Tenn. 800 w. Eng News—May 28, 1908. No. 92636.

A Reinforced Concrete Stock House. A. Jordahl. Illustrated description of a building under construction near Montreal, Can. 2500 w. Cement Age—May, 1908. No. 92296 C.

The Bostwick-Braun Building, Toledo, Ohio. C. A. P. Turner. Illustrated description of this reinforced-concrete structure. 2000 w. Eng Rec—May 2, 1908. No. 92067.

The First National Bank Building in Oakland, California. Illustrated detailed description of the methods of constructing this reinforced-concrete building on a triangular area. 2500 w. Eng Rec—May 16, 1908. No. 92315.

Reinforced-Concrete Brackets Under Skew Sidewalks. C. L. Slocum. Illustrated description of construction work in connection with improvements on the N. Y., N. H. & H. R. R. 500 w. Eng News—April 30, 1908. No. 92014.

The Influence of Transverse Stresses on the Arrangement of the Reinforcement in Reinforced-Concrete Beams (Einfluss der Querkräfte auf die Anordnung der Armierungen bei Eisenbetonbalken). Jhs. Thieme. A mathematical paper on beam design. Ills. 3300 w. Beton u Eisen—April 1, 1908. No. 92467 F.

See also Foundation, Piling, Stacks, and Underpinning, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; Tanks, under WATER SUPPLY; Piers, under WATERWAYS AND HARBORS; and Ties, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Skylights.

Skylight Construction. M. W. Pehl. Deals with systems of manufacture of metallic skylights. Ills. 700 w. Metal Work—May 2, 1908. Serial. 1st part. No. 92054.

Stacks.

Safe Design and Construction of Reinforced-Concrete Chimneys. The report of Sanford E. Thompson to the Assn. of Am. Portland Cement Mfrs. is given at some length. 7500 w. Engng-Con—May 20, 1908. No. 92512.

An Unusual Concrete Chimney. Brief illustrated description of the use of reinforced concrete for a combination of chimney, smoke and spark arrester, at Cumberland Mills, Me. 500 w. Eng Rec—May 2, 1908. No. 92074.

Steel Buildings.

A Companile 700 Feet High. Brief illustrated account of the tower of the Metropolitan Life Insurance Company's building, on Madison Sq., New York City. 1500 w. Sci Am—May 2, 1908. No. 92018.

The Construction of the New Kiel Theatre (Konstruktionen im neuer Stadttheater in Kiel). O. Leitholf. Illustrates and describes the structure and some constructive details. 5500 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—April 18, 1908. No. 92482 D.

See also Floors, under CONSTRUCTION.

Tunnels.

The Thames Tunnel. Reprint of a pamphlet published in 1840, describing the work, and giving the original illustrations. 2500 w. R R Gaz—May 22, 1908. No. 92521.

The Washington Street Tunnel of the Boston Subway System. Illustrated description of conctruction work under many difficulties. 3500 w. Eng Rec—May 16, 1908. No. 92310.

The New Blue Island Avenue Water Tunnel, Chicago. Illustrates and describes the 8-ft. circular tunnel, 28000 ft. long, being driven to form a part of the system to connect the intake cribs with the pumping stations. 3500 w. Eng Rec—May 9, 1908. No. 92204.

Underpinning.

Deep Underpinning for a Brick Fac-

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tory Building. Explains the difficult conditions and the successful methods employed. Ills. 1600 w. Eng Rec—May 2, 1908. No. 92073.

Method of Constructing Reinforced-Concrete Underpinning for 14-Story Building on Line of Washington Street Tunnel, Boston, Mass. Gives the plan adopted as described in the report of the chief engineer. 1200 w. Engng-Con—May 13, 1908. No. 92297.

Waterproofing.

See Floors, under BRIDGES; and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

MATERIALS OF CONSTRUCTION.

Cement.

Influence of Proportion of Water on the Compressive Strength of Cement, Mortar, and Concrete. Report of tests carried out by Herr Brabant, and published in the *Centralblatt der Bauverwaltung*. 500 w. Engr, Lond—May 15, 1908. No. 92567 A.

Concrete.

Tests of Coral Sand and Rock with Reference to Their Use in Concrete. Dewitt C. Webb. A report of tests and results. 500 w. Eng News—May 14, 1908. No. 92274.

See also Cement, and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Mortar.

See Cement, under MATERIALS OF CONSTRUCTION.

Reinforced Concrete.

Reinforced-Concrete Columns. P. Gillespie and W. G. Swan. Discusses experiments conducted in the testing laboratory of Toronto University. Ills. 3500 w. Can Engr—May 1, 1908. No. 92062.

Tests of Concrete and Reinforced-Concrete Columns; Series of 1907. Arthur N. Talbot. A report and description of investigations made at the University of Illinois engineering experiment station. Ills. 12000 w. Bul Univ of Ill, No. 20—Dec. 15, 1907. No. 92582 N.

Immunity from Rusting of Reinforcing Steel in Concrete. A report of results of tests made in Berlin, Germany, showing that ordinary tension cracks do not permit corroding influences to affect the steel. Also tests made at Key West, Fla. 1200 w. Eng News—May 14, 1908. No. 92275.

Timber Preservation.

The Burlington Tie-Preserving Plant at Galesburg. Illustrated description. 1500 w. Ry Age—May 8, 1908. No. 92227.

Preservation of Railroad Ties. Samuel M. Rowe. A summary of this industry, describing the processes. 3200 w. Ry Age—May 15, 1908. No. 92332.

New Tie-Treating Plants on the Rock Island Lines. Describes plants at Kansas City and at Argenta, Ark., using the Lowry method of creosoting at the first, and the Rueping process at the second named plant. 1800 w. Ry & Engng Rev—May 16, 1908. No. 92365.

A Review of the Present Practice and Economies of Timber Preservation. Eugene P. Schoch. Abstract of paper read before the S.-W. Elec. & Gas Assn. A discussion of this subject, giving proof that the practice of wood preserving is profitable. 4500 w. Elec Ry Rev—May 9, 1908. No. 92223.

Impregnation Processes for Mine Timbers (Procédés d'Imprégnation des Bois de Mines). Léon Delcommune. A review of the present processes for the preservation of mine timbers by impregnation with preservative materials. 5000 w. Bul Sci d l'Assn des Elèves—April, 1908. No. 92404 D.

MEASUREMENT.

Surveying.

Methods of Surveying Oyster Beds on Maryland Shores. Description taken from a recent address by Swepson Earle. 1200 w. Eng News—May 21, 1908. No. 92397.

Pioneer Engineering. Frederic Shelford. Suggestions for camp equipment are given in the present number, with illustrations. 5000 w. Engr, Lond—May 8, 1908. Serial. 1st part. No. 92357 A.

Some Historical Facts as to the Discovery and Use of the Magnetic Needle, and Some Facts from the Author's Experience with the Compass and Jacob Staff in Land Surveying in Louisiana. M. P. Robertson. 3500 w. Jour Assn of Engng Socs—April, 1908. No. 92589 C.

See also Location, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

MUNICIPAL.

Drainage.

Some Economic Advantages of Large Size Drain Tile. F. M. Okey. Gives advantages claimed and reasons. 2500 w. Engng-Con—April 29, 1908. No. 92042.

The Development of Agricultural Drainage in Illinois and Iowa—Controlling Laws, Physical Conditions and Costs. Jacob A. Harman. Read before the Iowa Drainage Assn. A study of drainage and its effects. 5000 w. Engng-Con—May 13, 1908. No. 92298.

Reserve Basins (Ueber Rückhaltebecken). Th. Heyd. Describes the arrangements made in Darmstadt to take care of storm-water drainage for which the pipe lines installed were inadequate. Ills. 2300 w. Gesundheits-Ing—April 4, 1908. No. 92451 D.

We supply copies of these articles. See page 658.

Garbage Disposal.

Refuse Destructor and Electricity Generating Station at Greenock. Illustrated detailed description. 2500 w. Engr, Lond —May 8, 1908. No. 92358 A.

The Cleveland, Ohio, Garbage Reduction Works. An outline of the process employed and of the apparatus used, with results. 2500 w. Eng Rec—May 23, 1908. No. 92535.

A 60-Ton Refuse Destructor in Seattle, Washington. Illustrated description of destructor of the regular Meldrum continuous-grate type, with four separate ash-pits. 3000 w. Eng Rec—May 2, 1908. No. 92070.

Re-grading.

The Re-grading of Seattle, Washington. Illustrated description of the reconstruction of a large portion of the city. 5000 w. Eng Rec—May 9, 1908. Serial. 1st part. No. 92202.

Roads.

Cost Data on Experimental Oiling of New York State Highways Together with the Results Obtained. From the report of Arnold G. Chapman, who supervised the experiments. 2500 w. Engng-Con—May 6, 1908. No. 92167.

Experiments with Dust Preventives on a Road at Wayland, Mass. Notes from an official circular issued by the Office of Public Roads. 5000 w. Eng Rec—May 2, 1908. No. 92068.

The Effect of Motors on Roads. W. J. Taylor. Read before the Incor. Inst. of Auto. Engrs. Remarks on the physical character of English roads, the effect of motors on the surface and foundations, dust, etc., with suggestions. 10700 w. Surveyor—May 15, 1908. No. 92547 A.

Sewage Disposal.

Sewage Pumping Station and Submerged Force Main, Salem, Massachusetts. William F. Bates. Illustrates and describes interesting features of this tidal water disposal system. 3500 w. Eng News—May 28, 1908. No. 92638.

Biological Purification Plants (Biologische Kläranlagen). August Marussig. A general discussion of their utility and efficiency. 4400 w. Oest Wochenschr f d Oeffent Baudienst—April 18, 1908. No. 92454 D.

Sewers.

Phenomena of the Crushing of Sewer Conduits. James N. Hazlehurst. Extract from a paper before the Am. Soc. of Munic. Imp., giving an account of failures of pipe sewers. 2500 w. Munic Engng—May, 1908. No. 92294 C.

The Employment of Rammed Concrete in the Construction of Sewers in Dresden (Die Anwendung des Stampfbetons bei den Dresdener Kanalbauten). Herr Pressprich. Illustrates and describes the structures and their construction. 1400 w. Serial. 1st part. Beton u Eisen—April 22, 1908. No. 92469 F.

Sewer Ventilation.

Sewer Ventilation and the Intercepting Trap. Francis J. H. Coutts and John S. Brodie. Two papers and general discussion. 9500 w. Jour Roy San Inst—May, 1908. No. 92317 B.

Bacteria in House Drain Pipes. Dr. F. J. H. Coutts. Describes the experiments made by Major W. H. Horrocks, recorded in a paper before the Royal Society, discussing the results, and methods of sewer ventilation. 2500 w. Munic Engng—May, 1908. No. 92293 C.

Street Cleaning.

See same title, under MECHANICAL ENGINEERING, AUTOMOBILES.

WATER SUPPLY.

Conduits.

See Tunnels, under CONSTRUCTION.

Conservation.

New York State Water-Storage and Water-Power Investigations. A review of the recent report submitted by John R. Freeman, with editorial. 5000 w. Eng News—April 30, 1908. No. 92016.

Croton Watershed.

Maximum Economical Storage Capacity of the Croton Watershed. An illustrated account of the Croton system of reservoirs and their capacity. Map. 900 w. Sci Am—May 23, 1908. No. 92506.

Dams.

The Concrete Dam of the Lynchburg Water Supply. Illustrations and description of details in the concrete block dam on the Peddlar River. 1000 w. Eng Rec —May 16, 1908. No. 92311.

A Small Concrete Dam. Samuel H. Lea. Illustrated description of a dam in South Dakota, as an example of quick and economic work. 1500 w. Eng Rec—May 9, 1908. No. 92211.

The Cataract Dam, Sydney, N. S. W. Illustrated description of this recently completed dam—the largest yet constructed in the Southern Hemisphere. 2000 w. Engng—April 24, 1908. No. 92121 A.

Method and Cost of Lock and Dam Construction by the U. S. Government on the Upper White River, Arkansas. Describes this work as given in official reports. Ills. 13000 w. Engng-Con—May 6, 1908. No. 92168.

Movable Dams for the Barge Canal. James Cooke Mills. Illustrates and describes the system of movable dams with Boule gates chosen for the Mohawk River. 1500 w. Can Engr—May 1, 1908. No. 92063.

The Break in the Hauser Lake Dam, Montana. F. L. Sizer. Illustrated account

of the failure of a dam on the Missouri River, built of steel bents supporting curved steel plates. 1000 w. Eng News —April 30, 1908. No. 92017.

Filtration.

The Experimental Water Filtration Plant and the Filter Plant Improvement of the People's Water Co., Oakland, Cal. W. W. de Berard and Langdon Pearse. Explains the conditions which made necessary a greatly increased supply, and describes the scheme developed to meet the demand. Ills. 3500 w. Eng News—May 21, 1908. No. 92396.

Sand Filtration (Discours over het Wezen der Zandfiltratie). J. M. K. Pennink. A very thorough discussion of all its features. Ills. 23506 w. De Ingenieur —April 18, 1908. No. 92495 D.

Fire Protection.

Fire Protection in the New Forrest Theater, Philadelphia, Pa. Especially describes the system of automatic sprinklers. 1700 w. Eng Rec—May 23, 1908. No. 92536.

See also Fireproofing, under CONSTRUCTION; Fire Boats, under MARINE AND NAVAL ENGINEERING; and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULICS.

Ground Waters.

Subterranean Waters. Inferences and illustration, based on a diagram and record, made by Prof. Adams, of registrations made in a bore-hole sunk in St. Paul's churchyard. 3500 w. Engr, Lond —May 15, 1908. No. 92565 A.

The Development of a Water-Supply from a Gravel-Bed. Edwin Duryea, Jr. Describes a development in the Santa Clara Valley, California. 2000 w. Cornell Civ Engr—May, 1908. No. 92601 C.

The Retention of Water by the Soil with Special Reference to the Formation of Ground Water (Das Verhalten des Bodens zum Wasser mit besonderer Berücksichtigung der Grundwasserbildung). Chr. Mezger. Ills. 10000 w. Gesundheits-Ing—April 18, 1908. No. 92453 D.

See also London, under WATER SUPPLY.

Irrigation.

Divi Pumping Project, Madras Presidency. Illustrates and describes works to supply water for irrigation of a portion of Divi Island, at the mouth of the Kistna River. 1200 w. Engr, Lond—May 15, 1908. No. 92566 A.

London.

Some Observations Upon the Underground Water Supplies to the Thames Basin. Clayton Beadle. Considers especially the Kent Water Works Co.'s area, the depletion, available supplies, future supplies and requirements, etc. Appendices and discussion. 9800 w. Jour Soc of Arts—May 15, 1908. No. 92548 A.

Oakland, Cal.

Outline of the New Water Supplies for Oakland, Cal., and Other Cities on the East Shore of San Francisco Bay. Philip E. Harroun. Map and description. 2800 w. Eng News—May 7, 1908. No. 92184.

Pipe Corrosion.

Corrosion of the Steel Water Supply Conduit at Rochester, N. Y. Richard H. Gaines. Describes the construction of the pipe lines, the rust leaks, method of combating the corrosion, method of repairing and related information. Ills. 14000 w. Eng News—May 28, 1908. No. 92637.

Pipe Flow.

Curve Resistance in Water Pipes. Ernest W. Schoder. Presents results of some measurements which seem to throw new light on this subject. Ills. 5500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92642 E.

Some Pitot Tube Studies. W. B. Gregory and E. W. Schoder. A study of the distribution of velocities and pressures in straight and curved portions of a six-inch water pipe. Ills. 3000 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92259 C.

Pipe Incrustation.

Experience with Water Pipe Incrustation at Quincy, Ill. Notes from papers by W. R. Gelston, and Dr. Edward Bartow, presented before the Am. Water Works Assn. 2500 w. Eng Rec—May 16, 1908. No. 92316.

Pipe Laying.

Cost of Hauling a Water Main Across Channel at Vancouver, B. C. Extracts from a paper by John Causley, before the Can. Soc. of Civ. Engrs., describing methods and giving costs of the work. 1700 w. Eng News—May 14, 1908. No. 92276.

Pipe Lines.

A Wood Pipe Conduit. T. Chalkley Hatton. Illustrated detailed description of work in Southern New Jersey. 2300 w. Munic Jour & Engr—May 6, 1908. No. 92153.

A Long Rifled-Pipe Line for Pumping Heavy Oils. Illustrated description of an 8-in. line in California, with a total length of 282 miles. 2800 w. Eng Rec—May 23, 1908. No. 92542.

Pipes.

Interesting Test of Spiral Riveted Pipe. Reports a test of 650 pounds per sq. in. without bursting. 900 w. Boiler Maker —May, 1908. No. 92089.

The Calculation of the Strength of Pipes under External Pressure (Festigkeits-Berechnung von röhrenartigen Körpern die unter äusserem Drucke stehen). E. Hurlbrink. A mathematical discussion of several forms, the first part of the serial dealing with conduits of elliptical

section. Ills. 3000 w. Serial. 1st part. Schiffbau—April 22, 1908. No. 92464 D.

Purification.

Operating Results of the Water Purification Plant at Ithaca, N. Y. E. M. Chamot. Information relative to the results and operation of the mechanical filters. 6000 w. Eng Rec—May 23, 1908. No. 92541.

See also Water Works, under WATER SUPPLY.

Reservoirs.

See Croton Watershed, under WATER SUPPLY.

Softening.

Operations of the Water Softening plant at Oberlin, Ohio. Notes on the operation, taken from the last report of W. B. Gerrish. 1000 w. Eng News—May 7, 1908. No. 92182.

Tanks.

The Distribution of Stresses in the Walls of Cylindrical Reservoirs (Ueber die Spannungsverteilung in zylindrischen Behälterwänden). H. Reissner. A mathematical paper on reinforced-concrete construction. Ills. 3000 w. Beton u Eisen —April 22, 1908. No. 92468 F.

Testing.

The Bacteriological and Microscopical Examination of Water. W. J. Dibdin. Read at conference of the Munic. Build. & Pub. Health Ex. (Abstract). Considers the importance of studying the character of waters in connection with bacteriological examinations. 2000 w. Surveyor—May 15, 1908. No. 92546 A.

Water Meters.

See same title, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Water Works.

New Orleans Water-Works. Illustrates and describes the pumping and purification plant. 2500 w. Munic Jour & Engr —May 6, 1908. No. 92152.

The Water Works System of Ottawa, Kan. Describes purification works for a river supply. Lime and sulphate of iron are used as coagulants. 1500 w. Eng Rec—May 23, 1908. No. 92543.

The Water-Supply System of Seattle, Wash. Describes a supply through a conduit 26 miles long, delivered to high reservoirs in the city. Ills. 2500 w. Eng Rec—May 23, 1908. No. 92538.

Long Distance Water Supply, El Paso & Southwestern Ry. Describes the general character and features of a project in New Mexico. 2000 w. Ry & Eng Rev —May 16, 1908. No. 92366.

Wells.

Driving a 36-Foot Well. George P. Pearce. Describes the work, and the difficulties met. 1500 w. Power—May 12, 1908. No. 92229.

Methods and Costs of Cleaning Driven Wells at Lowell, Mass. Robert J. Thomas. Describes methods used. 500 w. Eng News—May 7, 1908. No. 92183.

Small Water Supplies. W. H. Booth. Read at conference of the Munic., Build., & Pub. Health Ex. Discusses well systems and small streams as sources of water supply for small communities. 5800 w. Surveyor—May 15, 1908. No. 92545 A.

WATERWAYS AND HARBORS.

Barge Canal.

See Dams, under WATER SUPPLY.

Canada.

Transportation. M. J. Butler. Briefly describes the physical characteristics of Canada, and its water transportation routes, and railways. 6000 w. Can Engr —May 1, 1908. No. 92064.

Coast Erosion.

Coast Erosion. Dr. J. S. Owens. Discusses under-currents and their effects, winds, the nature of the bottom and its effect upon erosion and deposition, and other questions related. 3500 w. Engr, Lond—May 15, 1908. No. 92569 A.

Docks.

See Harbors, under WATERWAYS AND HARBORS.

Floods.

The Flood of March, 1907, on the Sacramento and San Joaquin River Basins, California. Continued discussion. 2500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92644 E.

See also River Regulation, under WATERWAYS AND HARBORS.

Great Lakes.

Transportation on the Great Lakes. Walter Thayer. Describes the origin, character and method of handling of the tonnage of the Great Lakes. 5000 w. R R Gaz—May 15, 1908. No. 92289.

Harbors.

Notes Upon Docks and Harbors. Luther Wagoner. Gives comparison of European and American harbors. 4500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92643 E.

Protection of Superior Entry. A criticism of the plan as now adopted to protect the entrance to the harbor at the city of Superior, Wis. Gives plan, and states objections, and gives a proposed plan. Ills. 3000 w. Marine Rev—April 30, 1908. No. 92055.

See also Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Locks.

Notes on the Footbridge, Lock and Weir, Richmond (Survey). J. H. Brierley. Points on the improvement of a tidal river, explaining the conditions and causes

and the remedy for the evils. Ills. 2300 w. Surveyor—May 15, 1908. No. 92544 A.

See also Dams, under WATER SUPPLY; and Mechanical Locks, under WATERWAYS AND HARBORS.

Mechanical Locks.

Electrically Operated Locks (Elektrisch betriebene Schiffs-Hebewerke). Albert Hundt. The first part describes the Henrichenburg locks on the Danube-Oder Canal. Ills. 2000 w. Serial. 1st part. Elektrotech Zeitschr—April 16, 1908. No. 92490 D.

Monongahela River.

The Monongahela River. T. P. Roberts. Some of its characteristics and brief sketch of methods undertaken for the improvement of its navigation. Discussion. 8500 w. Pro Engrs' Soc of W Penn—May, 1908. No. 92612 D.

Piers.

Concrete Pier Construction on the Pacific Coast. H. A. Crafts. Describes special applications of sheathed and reinforced concrete. Ills. 1200 w. Cassier's Mag—May, 1908. No. 92147 B.

River Regulation.

The Relation of Water Conservation to Flood Prevention and Navigation in the Ohio River. M. O. Leighton. A paper prepared as an appendix to the Preliminary Report of the Inland Waterways Commission. Discusses the reservoir system of river control. An important paper, with editorial. 12500 w. Eng News—May 7, 1908. No. 92179.

U. S. Waterways.

The Waterways Problem. Lewis M. Haupt. A review of the present situation in the United States and the remedies suggested. 6500 w. Jour Fr Inst—May, 1908. No. 92590 D.

The Relation of the Southern Appalachian Mountains to Inland Water Navigation. M. O. Leighton and A. H. Horton. Gives results of a study of most of the navigable rivers of this region, discussing the effect which a system of reservoirs and the preservation of the forests would have on the general value of these streams. 12000 w. U S Dept of Agri—Circ 143. No. 92581 N.

Water Powers.

See Conservation, under WATER SUPPLY.

MISCELLANY.

Egypt.

Engineering in Egypt and the Soudan. Reviews the "White Book of Egypt, No. 1 (1908)" in so far as the reports are of interest to engineers. 2500 w. Engr, Lond—May 8, 1908. No. 92361 A.

Natural Resources.

The Conference on the Conservation of Natural Resources. A report of the papers and proceedings, with editorial on the results attained. Plate. 21000 w. Eng News—May 21, 1908. No. 92399.

Saving the Forests and Streams of the United States. Dr. Thomas E. Will. Discusses the economic importance of this question. Ills. 3500 w. Jour Fr Inst—May, 1908. No. 92591 D.

The Conservation of Power Resources. H. St. Clair Putnam. Abstract of an address at the conference at Washington. Discusses the available sources of power. 4500 w. Power—May 26, 1908. No. 92599.

Conservation of Ores and Minerals. Andrew Carnegie. Part of address before the White House conference. On the waste and methods of delaying their exhaustion. 3000 w. Eng & Min Jour—May 23, 1908. No. 92531.

April Meeting on the Conservation of Our Natural Resources. A report of the meeting called by the President of the U. S. to coöperate for securing the conservation of the natural resources of the country. 5000 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92258 C.

Soil Erosion.

Forest Destruction and the Erosion of Arable Lands. Day Allen Willey. An illustrated account of earth erosion in the western part of the United States, and the results, and methods of prevention. 2000 w. Sci Am—May 23, 1908. No. 92507.

ELECTRICAL ENGINEERING

COMMUNICATION.

Condensers.

The Manufacture of Electrical Condensers. G. F. Mansbridge. Gives numerical data obtained from workshop tests, considering the subject from the practical point of view. 11000 w. Inst of Elec Engrs—May, 1908. No. 92347 N.

Cylindrical Condensers (Condensadores cilindricos). Ricardo Caro. A mathematical paper on the derivation of capacity formulae for condensers of this type. Ills. 4000 w. Energia Elec—April 25, 1908. No. 92430 D.

High-Tension Condensers and Their Industrial Applications (Los Condensadores industriales de alta Tensión y sus Applicaciones). J. M. Borrell. A theo-

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retical discussion of their design and functions and a brief review of their more important practical applications. Ills. 3000 w. Rev Tech Indus—March, 1908. No. 92427 D.

Radio-Telegraphy.

See Tele-Photography, under COMMUNICATION.

Radio-Telephony.

A Practical System of Wireless Telephony. Leon L. Thomas. An illustrated explanation of the system of Dr. Lee De Forest. 2000 w. Jour Worcester Poly Inst—May, 1908. No. 92577 C.

Signal Horns.

Electric Signal Horns (Elektrische Signalhuppen). Kurt Perlewitz. Illustrates and describes many types. 3500 w. Elektrotech Zeitschr—April 30, 1908. No. 92493 D.

Telegraph Cables.

See Telephone Cables, under COMMUNICATION.

Telephone Cables.

The Design and Use of Telephone and Telegraph Cables. F. Tremain. Abstract of paper before the Newcastle Loc. Soc. of the Inst. of Elec. Engrs. Deals with the construction and use of paper-insulated lead-sheathed cables. 4000 w. Elect'n, Lond—April 24, 1908. No. 92117 A.

Telephone Exchanges.

The Destruction of the Central Telephone Exchange of Anvers and the Temporary Replacement of the Installations (La Destruction du Bureau Central des Téléphones d'Anvers et le Rétablissement provisoire des Installations). Emile Piérard. An account of the destruction of the exchange by fire and the temporary arrangements for the continuance of service during the construction of a new building. Ills. 6000 w. Soc Belge d'Elecns —April, 1908. No. 92406 E.

Telephony.

A Study of Multi Office Automatic Switchboard Telephone Systems. W. Lee Campbell. Discusses the enormous waste involved, the reasons that make the waste necessary in manually operated systems, and how it can be reduced in systems employing automatic switchboards. 7000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92390 D.

Tele-Photography.

Knudsen's System of Wireless Transmission of Photographs. Brief illustrated description. 7000 w. Elect'n, Lond—May 1, 1908. No. 92243 A.

DISTRIBUTION.

Fuses.

Cartridge-Type Fuses. Illustrates and describes various types. 1500 w. Elec Engr, Lond—April 24, 1908. No. 92110 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Modern Development in Single-Phase Generators. W. L. Waters. A discussion of the difficulties met and overcome. Ills 2200 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92382 D.

Parallel Operation of Alternators. Henry Herman. Analysis of the action in a synchronous unexcited machine, explaining the development of torque. Also editorial. 2000 w. Elec Wld—May 23, 1908. No. 92505.

Theoretical and Practical Notes on the Parallel Operation of Alternating-Current Generators (Theoretisches und Praktisches über den Parallelbetrieb von Wechselstrommaschinen). L. Fleischmann. A mathematical discussion. Ills. 2800 w. Elektrotech a Maschinenbau—April 19, 1908. No. 92462 D.

A New Method of Voltage Regulation in A. C. Dynamos (Ein neues System der Spannungsregelung für Wechselstrom-Generatoren). M. Seidner. Illustrates and describes the proposed arrangement. 4000 w. Elektrotech Zeitschr—April 30, 1908. No. 92494 D.

Deformation of the Voltage Curves of Single and Polyphase Generators under Load (Die Veränderung der Spannungskurven bei belasteten Ein- und Mehrphasengeneratoren). Egon Siedek. A mathematical paper, based on experiments, illustrated by curves and diagrams. 2800 w. Elektrotech u Maschinenbau—April 5, 1908. No. 92461 D.

The Deformation of the Voltage Curve of Alternators when Loaded. E. Siedek. Abstract translation from *Elektrotechnik und Maschinenbau*. An experimental study. 1500 w. Elec Engr, Lond—April 24, 1908. No. 92111 A.

See also Windings, under DYNAMOS AND MOTORS.

A. C. Motors.

A Single Alternating-Current Motor. Frederick E. Ward. Illustrated detailed description of how it can be built at home. 4000 w. Sci Am Sup—May 9, 1908. No. 92194.

The Single-Phase Commutator-Type Motor. B. G. Lamme. Describes methods of commutation at slow speed and full speed, the effect of reduction in frequency, discussing the question of power factor and other problems related. 6500 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92392 D.

Brakes.

A New Type of Friction Brake. H. D. James. Illustrated description of a cast-iron brake bearing on a cast-iron wheel. 1500 w. Elec Jour—May, 1908. No. 92292.

We supply copies of these articles. See page 658.

D. C. Dynamos.

Direct-Current Generators for Light, Power and Tramway Service. E. Korrodi. Considers the advantage of using one type of generator for the combined service, and the operation of the machines. 2000 w. Elect'n, Lond—May 1, 1908. No. 92242 A.

Parallel Operation of Direct Current Generators. H. R. Mason. Considers some modifications demanded under certain circumstances. Diagram. 2000 w. Power—May 26, 1908. No. 92600.

The Iglésis-Regner Dynamo with Constant Output at Variable Speeds (Dynamo Iglésis-Regner à Débit Constant sous Vitesses variables). M. Iglésis. Illustrates and describes a dynamo particularly adapted to train lighting. 6000 w. Bul Soc Int d'Elecns—April, 1908. No. 92407 F.

See also Interpoles, under DYNAMOS AND MOTORS.

D. C. Motors.

Direct Current Motors. An explanation of some of the terms and the operation of such motors. 1200 w. Ry & Loc Engng—May, 1908. No. 92059 C.

See also Interpoles, under DYNAMOS AND MOTORS.

Induction Motors.

Operation of Polyphase Induction Motors. R. H. Fenkhausen. Treats of autostarters, motor installation, causes of short circuits, etc. 2000 w. Power—May 5, 1908. No. 92141.

See also Electric Power, under MINING AND METALLURGY, MINING.

Interpoles.

The Influence of Interpoles on the Operation of D. C. Dynamos and Motors (Der Einfluss der Wendepole auf die Leistung der Gleichstromdynamomaschinen und -Motoren). Hermann Zipp. The first part of the serial is mathematical and theoretical. Ills. 2400 w. Serial. 1st part. Elektrotech u Polytech Rundschau —April 17, 1908. No. 92463 D.

Pole Pieces.

Pole Piece Design for Dynamos. E. A. Löf. Gives present practice in designing the punchings, end-plates, rivets and bolts. Ills. 700 w. Mach, N Y—May, 1908. No. 92094 C.

Railway Motors.

Motors for Electric Traction (Tracción electrica : Motores). Luis Pereda. A discussion of the various types adapted to railway service. Ills. 5000 w. Energia Elec—April 10, 1908. No. 92429 D.

Windings.

Application of Fractional Pitch Windings to Alternating-Current Generators. Jens Bache-Wüg. Considers points leading to the use of chorded winding for a.-c. generators from the standpoint of manufacture and design, indicating the influence the winding has on the performance of a machine. 2000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92387 D.

ELECTRO-CHEMISTRY.

Alkalies.

The Electrolytic Alkali and Bleach Industry in 1907. John B. C. Kershaw. A report for Europe and America of the present capacity of the works. 2000 w. Elect'n, Lond—April 24, 1908. No. 92114 A.

Calcium Cyanamide.

The Manufacture of Calcium Cyanamide. John B. C. Kershaw. General remarks on artificial fertilizers with a description of the Frank and Caro process for the fixation of nitrogen. Ills. 3000 w. Elec Wld—May 9, 1908. No. 92178.

Corrosion.

Electrolytic Corrosion. W. W. Haldane Gee. Abstract of paper and discussion presented at the Manchester Loc. Sec. of the Inst. of Elec. Engrs. Deals with the conditions which may produce corrosion, and with suggestions for its prevention. 7500 w. Elect'n, Lond—April 24, and May 1, 1908. Serial. 2 parts. No. 92241 each A.

Electrochemical Society.

Albany Meeting of the American Electrochemical Society. An illustrated account of the recent meeting with abstracts of papers presented, dealing with resistances, absorption, cells, fundamental units, corrosion, light, alloys, concentration, refining, etc. 18800 w. Elec-Chem & Met Ind—June, 1908. No. 92619 C.

Electro-Metallurgy.

The Electro-Chemical Industry (Die elektrochemische Industrie). Dr. Stange. Begins a statistical and historical review of the development of electro-metallurgy. 2500 w. Serial. 1st part. Elektrochem Zeitschr—April, 1908. No. 92433 D.

Glass Making by Electricity (Fabrication électrique du Verre). E. Zampini. Illustrates and describes the application of the electric furnace in the glass industry. 1500 w. Serial. 1st part. Rev d'Eletrochim et d'Electrométal — Feb.-March, 1908. No. 92408 F.

A New Electric Arc Furnace for Laboratory Researches, due to Louis Clerc and Adolph Minet (Sur un nouveau Four électrique à Arc applicable aux Recherches du Laboratoire dû à MM. Louis Clerc et Adolphe Minet). Adolphe Minet. Illustrated description. 1500 w. Serial. 1st part. Rev d'Electrochim et d'Electrométal—Feb.-March, 1908. No. 92409 F.

See also same title, under MINING AND METALLURGY, IRON AND STEEL.

We supply copies of these articles. See page 658.

Electro-Plating.

Copper Plating. Frederich Hartmann. Trans. from *Das Verzinnen Verzinken.* An explanation of methods. 1000 w. Sci Am Sup—May 9, 1908. No. 92193.

Recovery of Gold and Silver Residues. Dr. Theodor Koller. Abstract translation from *Handbuch der Verwertung, etc.* Practical suggestions. 3000 w. Sci Am Sup—May 23, 1908. No. 92510.

Russia.

Technical Electrochemistry in Russia. N. Piltschikoff. Read before the Faraday Soc. 500 w. Elec Engr, Lond—May 8, 1908. No. 92349 A.

ELECTRO-PHYSICS.

Cells.

Electricity from Coal. Editorial discussion of the claims of carbon-consuming batteries. 2500 w. Elec Age—April, 1908. No. 92218.

Electrons.

The Electron Theory. Edward A. Partridge. An explanation of the electron theory, describing briefly its experimental foundations. 4000 w. Jour Fr Inst. May, 1908. No. 92594 D.

Oscillations.

A New Method of Obtaining Undamped Oscillations. O. M. Corbino. Translated from *L'Elettricista.* Explains method and principle upon which it is based. 700 w. Elect'n, Lond—April 24, 1908. No. 92116 A.

GENERATING STATIONS.

Accumulators.

Installation and Operation of Electric Accumulators (Installation et Fonctionnement des Accumulateurs électriques). Marcel Fontan. Their construction, installation, operation and care are discussed. Ills. 2000 w. Rev d'Econ Indus—April 16, 1908. No. 92401 D.

Central Station.

Power Station for Delaware & Hudson Company. Illustrated description of steam-turbine station at Mechanicsville, N. Y. 1300 w. St Ry Jour—May 9, 1908. No. 92166.

Recent Extensions of the Manchester Electrical Department. An illustrated article showing the rapid development taking place in this city. 2300 w. Elec Rev, Lond—May 15, 1908. No. 92554 A.

The Commonwealth Edison Company. Illustrates and describes the system supplying electricity for Chicago and vicinity. 2500 w. Elec Rev, N Y—May 16, 1908. No. 92304.

The System and Operating Practice of the Commonwealth Edison Company, Chicago. Illustrated detailed description of the system and its operation. 13500 w. Elec Wld—May 16, 1908. No. 92338.

See also Garbage Disposal, under CIVIL ENGINEERING, MUNICIPAL.

Hydro-Electric.

Ice Troubles in Hydraulic Power Work and Methods of Overcoming Them. John Murphy. Address at McGill Univ. Explains troubles caused by frazil ice and success by fighting it with a small steam plant. Ills. 5000 w. Can Engr—May 1, 1908. No. 92065.

The Kashmir Power Scheme. An illustrated descriptive account of the development of the Jhelum River, which is to develop 20000 h.p. 2500 w. Elec Engr, Lond—May 15, 1908. No. 92553 A.

A Hydro-Electric Development in American Fork Canyon, Utah. A. P. Merrill. Illustrated description with information relating to the work. 3000 w. Eng Rec—May 9, 1908. No. 92206.

The Post Falls Development of the Washington Water Power Company. C. S. MacCalla. Illustrated description of a plant in Idaho to be operated in parallel with the Spokane hydraulic and steam plants, with controlling works for the storage of water. 2500 w. Elec Wld—May 23, 1908. Serial. 1st part. No. 92503.

A Combined Steam and Hydraulic Generating Station in Switzerland. Frank Koester. Illustrated description of a plant at Beznau on the Aare, employing high and low-water hydraulic turbines as well as steam turbines. 2500 w. Eng Rec—May 16, 1909. No. 92309.

The High-Tension Power Development of the Urft Valley (Die Hochspannungs-Kraftübertragung an der Urfttalsperre). Illustrated description of dam, power house, transmission lines, etc. 1500 w. Serial. 1st part. Elektrotech Zeitschr—March 19, 1908. No. 92486 D.

The Power Developments of the Rur Valley Company (Die Kraftübertragungsanlagen der Rurtalsperren-Gesellschaft). Franz Bauwens. Illustrated description of the four power plants and the transmission line and other installations of this large company. 6000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—April 18, 1908. No. 92481 D.

Management.

Meter Department of the Central Station. Joseph B. Baker. Considers the evolution of the meter department, meter readings, numbering systems, the stock-room, records, etc. 5400 w. Elec Age—June, 1908. No. 92367.

Operation.

See A. C. Dynamos, under DYNAMOS AND MOTORS.

Switchboards.

Meter and Relay Connections. Harold W. Brown. Presents a few principles to be observed in making connections, ap-

plying them to questionable cases. 2000 w. Elec Jour—May, 1908. No. 92291.

Tariffs.

Modern Methods of Charging (Beitrag zur modernen Tarifbildung). Th. Gruber. A comparison of methods of establishing charges for electrical energy for lighting and power. Ills. 3500 w. Elektrotech Zeitschr—March 26, 1908. No. 92489 D.

Transformers.

See same title, under TRANSMISSION.

LIGHTING.

Illumination.

The Problem of Illumination. Arthur J. Sweet. Read before the Pittsburg Sec. of the A. I. E. E. Considers the paramount importance of efficiency and the meaning of the term. 5500 w. Elec Age —April, 1908. No. 92220.

Economical Aspects of the Various Electric Illuminants. Alfred A. Wohlauer. Gives economic statistics and conclusions. 1500 w. Elec Wld—May 16, 1908. No. 92340.

A New Method of Obtaining Polar Curves of Distribution of Light of Artificial Illuminants. W. Voege. Abstract translation from *Elek. Zeit.* Explains the use of a thermopile and the precautions to render the method sufficiently accurate for practical use. 1800 w. Elect'n, Lond —May 8, 1908. No. 92353 A.

Incandescent Lamps.

The New Incandescent Lamps. Francis W. Willcox. Abstract of a paper before the Iowa Elec. Assn. Discusses the tantalum, and the tungsten lamps and the effect they will have on the lighting industry. 3500 w. Elec Rev, N Y—May 16, 1908. No. 92307.

Tungsten Development. A. H. Keleher. On the present standing of the new tungsten lamp. 1200 w. Elec Rev, N Y—May 16, 1908. No. 92305.

Metallic and Carbon Filaments (Filaments métalliques et Filaments de Carbone). Compares the results of comparative researches on illuminating power of various filaments, made by Hirschauer in Germany and Loring in America. Ills. 2000 w. L'Elecn—April 25, 1908. No. 92413 D.

The Metallic Filament Incandescent Lamps (Les Lampes à Incandescence à Filaments Métalliques). G. de Lamarcodie. A review of recent advances in tantalum, tungsten, osmium and zinconium lamps. Ills. 3000 w. Rev Gen d Sci—April 15, 1908. No. 92410 D.

Photometry.

Photometers. Joseph H. Hart. Remarks on their development and use. 1800 w. Elec Rev, N Y—May 23, 1908. No. 92517.

MEASUREMENT.

Cable Testing.

The High-Tension Testing Plant of the Siemens-Schuckert Cable Factory, Nonnendamm (Die Hochspannungsprüfanlagen der Kabelfabrik der Siemens-Schuckertwerke, Nonnendamm). Leo Lichtenstein. Illustrated description of equipment and methods. 2400 w. Serial. 1st part. Elek Kraft u Bahnen—April 14, 1908. No. 92474 D.

Dynamo Testing.

Artificial Loads for Testing Electrical Generators. R. K. Morcom and D. K. Morris. Abstract of a paper read before the Birmingham Loc. Sec. of Inst. of Elec. Engrs. Deals with the use of water resistances as artificial loads and gives details of a tank for high-tension testing, giving an account of experimental investigations. Discussion. 5000 w. Elect'n, Lond—April 17, 1908. No. 91994 A.

Insulator Testing.

See Insulators, under TRANSMISSION.

Meters.

See Management, under GENERATING STATIONS.

Power Factor.

Three-Phase Power Factor. Austin Burt. Derives a general expression which will enable the mean power-factor to be determined, and develops a method by which the required values may be determined from the standard switchboard instruments. 2000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92385 D.

Stroboscope.

The Measurement of Rotary Speeds of Dynamo Machines by the Stroboscopic Fork. A. E. Kennelly and S. E. Whiting. Calls attention to what has been accomplished and to a modification of the principle which has been developed by the authors. Ills. 3500 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92391 D.

Transformer Testing.

Transformer Testing. W. M. Hollis. Outlines a method of determining the full-load efficiency in which only a fraction of the full-load energy is required and few instruments. 1300 w. Elec Wld —May 2, 1908. No. 92005.

TRANSMISSION.

Arcing Grounds.

Tests with Arcing Grounds and Connections. Ernst J. Berg. A report of tests. 2000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92389 D.

Cable Records.

Subway and Cable Records for Electric Light Companies. Charles Holmberg. Directions for drawing a cable report. Ills. 1200 w. Elec Wld—May 2, 1908. No. 92004.

We supply copies of these articles. See page 658.

Cables.

See Telephone Cables, under COMMUNICATION; and Insulation, under TRANSMISSION.

Cable Troubles.

A Few Unusual Burn-Outs of Underground Cables. D. W. Roper. Describes cable troubles where the arc at the point of break down, or the current flowing to the lead sheath, injures other cables. Ills. Discussion. 9000 w. Jour W Soc of Engrs—April, 1908. No. 92321 D.

Conduits.

Underground Conduits. E. S. Larned. Illustrates and describes a new monolithic duct system for telephone, telegraph, electric light and power conduits. 2500 w. Cement Age—May, 1908. No. 92295 C.

Inductance.

Inductance of Electric Transmission Lines with Unsymmetrically Disposed Conductors. Alfred Still. Gives an analysis of the e.m.f.'s induced in a multiphase transmission line. 1800 w. Elec Wld—May 23, 1908. No. 92504.

The Inductive Effect in Parallel Conductors (Ueber die Induktionswirkungen paralleler gestrekter Leiter). E. Orlich. A mathematical discussion. Ills. 2500 w. Elektrotech Zeitschr—March 19, 1908. No. 92487 D.

Insulation.

Cable Insulation. Compiled from notes by W. A. Del Mar. Deals with materials used, their thickness, calculations, tests, etc. 4000 w. Elec Age—June, 1908. No. 92368.

Insulators.

The Testing Laboratory of the Hermsdorf Porcelain Works. William Weicker. Illustrated description of this laboratory in Germany and the tests made. 2000 w. Elect'n, Lond—April 24, 1908. No. 92115 A.

Lightning.

Studies in Lightning Performance, Season 1907. N. J. Neall. Discusses line disturbances on the Taylor's Falls line of the Minneapolis Electric Co.; and station lightning phenomena at Cumberland Mills, near Portland, Me. Ills. 8000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92381 D.

Lightning Protection.

Comparative Tests of Lightning Protection Devices on the Taylor's Falls Transmission System. J. F. Vaughan. Gives data obtained on an operating line equipped experimentally with various protective devices. Ills. 4000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92380 D.

Lines.

Distribution of Niagara Energy in Auburn. Illustrates and describes an interesting secondary system for distributing energy. 1200 w. Elec Wld—May 2, 1908. No. 92002.

Central Station Distributing System. H. B. Gear and P. F. Williams. A discussion of secondary distributing systems, their design, advantages, etc. 5000 w. Elec Age—April, 1908. No. 92219.

See also Hydro-Electric, under GENERATING STATIONS.

Protective Devices.

Modern Arrangements for Protection against Dangerous Currents in Transmission Lines (Moderne Schutzeinrichtungen gegen gefahrbringende Ströme in elektrischen Netzen). Karl Kuhlmann. A theoretical and practical discussion of such devices. Ills. 4500 w. Serial. 1st part. Elektrotech Zeitschr—March 19, 1908. No. 92488 D.

Substations.

See same title, under STREET AND ELECTRIC RAILWAYS.

Transformers.

The Series Transformers. E. S. Harrar. Explains the action, developing formulae. 2000 w. Elec Wld—May 16, 1905. No. 92341.

The Choice of Transformers for Central Stations. L. A. Sterrett. Claims that low all-day efficiency is not economical, and that the best and cheapest service is secured by buying the transformer with the best regulation. 800 w. Elec Wld—May 2, 1908. No. 92003.

See also Transformer Testing, under MEASUREMENT.

Voltage Regulation.

Compensation of Pressure Variations on Alternate-Current Networks Supplying Motors. A. Heyland. Describes several arrangements which not only compensate the drop, but may produce "over-compensation" if desired. 2500 w. Elect'n, Lond—April 24, 1908. No. 92113 A.

Wire Suspension.

The Tangential System of Suspending Overhead Trolley and Transmission Wires. Robert N. Tweedy. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Presents the advantages of this system and its economy. 5000 w. Elect'n, Lond—May 15, 1908. No. 92557 A.

MISCELLANY.

A. C. Diagrams.

The Alternating-Current Circle Diagram. Charles F. Smith and William Cramp. Gives a number of cases illustrating their use. 2500 w. Mech Engr—May 1, 1908. Serial. 1st part. No. 92237 A.

Fire Risk.

Electricity as Viewed by the Insurance Engineer; Should the A. I. E. E. Interest Itself in Fire Protection? C. M. Goddard. Gives statistics of fire losses, urging united action. 2200 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92388 D.

We supply copies of these articles. See page 658.

Franco-British Exhibition.

The Franco-British Exhibition. An illustrated description of the electric lighting and wiring. 3000 w. Elect'n, Lond—May 15, 1908. No. 92558 A.

Hotel Equipment.

The Electrical Equipment of the Piccadilly Hotel (London). Illustrated descriptions of the applications for lighting, power, telephones, bells, heating, clocks, etc., at this new hotel. 2500 w. Elect'n, Lond—May 8, 1908. No. 92352 A.

Kelvin.

The Kelvin Lecture. Abstract of the first of the Kelvin annual lectures, delivered by Prof. Silyanus Thompson, the subject being "The Life and Work of Lord Kelvin." 6000 w. Elect'n, Lond—May 8, 1908. No. 92351 A.

Resistance Coils.

Construction of Resistances. Shows how a little care in construction can make appliances nearly perfect. 1100 w. Elec Engr, Lond—April 24, 1908. No. 92109 A.

INDUSTRIAL ECONOMY

Apprenticeship.

The Crisis of Apprenticeship (La Crise de l'Apprentissage). Paul Besson. Discusses the moral, economic and legislative causes of the decline of apprenticeship in France and the possible remedies. 6500 w. Mem Soc Ing Civ de France—Feb., 1908. No. 92402 G.

Commercial Research.

Commercial Research. C. E. Skinner. An address at Purdue University. A discussion of its field and methods, with particular reference to the electrical manufacturing industry. 7000 w. Elec Jour—April, 1908. No. 92038.

Cost Systems.

A Practical Foundry Cost System. Explains methods used in a foundry at Seneca Falls, N. Y. 1400 w. Foundry—May, 1908. No. 92050.

Obtaining Actual Knowledge of the Costs of Production. F. E. Webner. This second article of a series, explains when and where a close knowledge is needed. 2000 w. Engineering Magazine—June, 1908. No. 92623 B.

Education.

The Teaching of Evening Students in Engineering. W. J. Crawford. Discusses the necessary qualifications, and the methods of the teachers. 4000 w. Elec Rev, Lond—May 15, 1908. No. 92556 A.

Technical Welfare Work. Sydney Whitmore Ashe. Considers the raising of the standing of employees who have not had a college training. 3000 w. Elec Wld—May 16, 1908. No. 92342.

Discussion on "The Education of the Electrical Engineer," at New York, January 24, 1908. 27000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92379 D.

Mathematics and Engineering. Prof. W. C. Kernot. Read before the Victorian Inst. of Engrs. A discussion of how much and what kind of mathematics is needed by an engineer. 2500 w. Aust Min Stand—April 8, 1908. Serial. 1st part. No. 92255 B.

The Relation Between Recent Industrial Progress and Educational Advance. Frank T. Carlton. An interesting review of the industrial development of the United States and the demands on the educational system. 7000 w. Pop Sci M—June, 1908. No. 92617 C.

President Humphreys' Address at the Annual Alumni Dinner of Stevens Institute. A presentation of the author's opinions on certain features of engineering education. 6500 w. Stevens Ind—April, 1908. No. 92586 D.

Engineering and Industrial Education. Fred A. Geier. On the results obtained by coöperation between manufacturers and the Univ. of Cincinnati. 3200 w. Am Mach—Vol. 31. No. 19. No. 92156.

A Four-Years Course in Industrial Engineering. Hugo Diemer. Presents a proposed scheme for preparing the student for industrial work, comparing with twelve well-known courses. 4500 w. Engineering Magazine—June, 1908. No. 92624 B.

Engineering.

A Study of Engineering. Albert J. Himes. An address delivered at the 5th annual banquet of the Cornell Assn. of Civ. Engrs. 6000 w. Cornell Civ Engr—May, 1908. No. 92602 C.

Engineering Ethics.

See same title, under MINING AND METALLURGY, MINING.

Exhibitions.

The Franco-British Exhibition. Plan and illustrated description of buildings and other features. 2500 w. Engng—May 15, 1908. Serial. 1st part. No. 92563 A.

Labor.

The Young American Workman as Seen by a Shop Superintendent. C. R. McGahey. A reply to an article in the April number of this magazine. Considers trade schools a remedy for defective homé and union training. 1000 w. Engineering Magazine—June, 1908. No. 92626 B.

We supply copies of these articles. See page 658.

Management.

Task and Bonus in Management. H. L. Gantt. Gives an application of this method. 3500 w. Stevens Ind—April, 1908. No. 92584 D.

Storing, Issuing and Accounting for Material. Oscar E. Perrigo. Eighth of a series of articles on cost keeping and shop management. 3500 w. Ir Trd Rev—May 7, 1908. No. 92161.

The Management of Engineering Workshops. Eustace Thomas. Read before the Inst. of Elec. Engrs. Gives examples of modern management. 7000 w. Ir & Coal Trds Rev—April 24, 1908. No. 92135 A.

Maximum Production Through Organization and Supervision. C. E. Knoeppel. This third article of the series deals with economy in the use of materials and time. 5000 w. Engineering Magazine—June, 1908. No. 92627 B.

See also Commercial Research, Cost Systems, and Wages, under INDUSTRIAL ECONOMY.

Profit Sharing.

Co-Partnership. Sir George Livesey. Abstract of paper read before the Gt. W. Ry. Lecture and Debating Soc., London. An explanation of the system and its advantages. 3000 w. Ir & Coal Trds Rev—April 24, 1908. No. 92134 A.

Safety Devices.

The American Museum of Safety Devices. Herbert T. Wade. Explains the purpose and economic value, giving an illustrated description of exhibits. 4500 w. Engineering Magazine—June, 1908. No. 92622 B.

Stores Keeping.

See Management, under INDUSTRIAL ECONOMY.

Wages.

Piece Work and Premium Work. An editorial on the strength and weakness of these plans with special reference to railroads. 2000 w. R R Gaz—May 8, 1908. No. 92169.

Experience with the Piece Work and Premium Plans. Clinton Alvord. Gives instances showing the working of these systems. 2000 w. Am Mach—Vol. 31. No. 19. No. 92157.

MARINE AND NAVAL ENGINEERING

Armor.

Regarding Armor and Its Attack. J. B. Van Brussel. Reviews the history of its use for the protection of ships, the improvements made and processes of manufacture, discussing the attack, and giving tests. Ills. 2500 w. Sci Am Sup—May 2, 1908. No. 92019.

Battleships.

H. M. SS. Agamemnon and Indomitable. Illustrations with brief description. 600 w. Engr, Lond—April 24, 1908. No. 92131 A.

The New German Battleship "Ersatz-Bayern." Illustrates a recently launched vessel, with brief description. 500 w. Sci Am Sup—May 9, 1908. No. 92191.

Cruisers.

The French Armored Cruiser Edgar Quinet. J. G. Peltier. Illustrated description of the largest armored cruiser ever built on the continent of Europe. 700 w. Int Marine Engng—June, 1908. No. 92374 C.

Dredges.

New Sea-going Dredge Raritan. Brief description, with illustration. 700 w. Naut Gaz—May 28, 1908. No. 92631.

Electric Power.

The Electric Generating Station on Shipboard (Le Centrali elettriche a Bordo delle Navi). Giuseppe Belluzzo. A discussion of electric power for ship propulsion as a means of avoiding the difficulties of high-speed in steam turbines. Ills. 3000 w. L'Indus—April 12, 1908. No. 92422 D.

Fire-Boats.

Electrically-Propelled Fire Boats for Chicago. Describes the boats and their equipment, giving plan and elevation. 2000 w. Elec Wld—May 16, 1908. No. 92339.

Gas Engines.

Capitaine Producer-Gas-Driven Ship. An account of trials carried out upon the Clyde. 1200 w. Sci Am Sup—May 23, 1908. No. 92508.

Gasolene Engines.

The Redbridge 8-Cyl. Marine Engine. Illustrates and describes the constructional features. 1200 w. Auto Jour—April 25, 1908. No. 92104 A.

The Internal-Combustion Engine. W. G. Winterburn. An elementary description of the gasolene engine as used for propelling small vessels. 2500 w. Naut Gaz—May 29, 1908. No. 92632.

See also Motor Boats, under MARINE AND NAVAL ENGINEERING.

Hydroplanes.

The Hydroplane (L'Idroplano). G. Arturo Crocco. Discusses fully the theory of their design and describes the types already built. Ills. 10000 w. Rivista Marit—April, 1908. No. 92421 E + F.

We supply copies of these articles. See page 658.

Motor Boats.

How to Build a Launch for $100. Describes the building of the launch "Minnow." Ills. 2000 w. Rudder—May, 1908. Serial. 1st part. No. 92137 C.

Commercial Power Boats of the Northwest Pacific Coast. F. M. Foulser. Shows the important place won for the gasolene engine in the fishing and coasting industries, and for river and lake boats. Ills. 2500 w. Rudder—May, 1908. No. 92139 C.

Oil Firing.

A Patent Oil-Firing System. A. K. Fisher. Illustrates and describes the system invented by Ernest Koerting, used so successfully on the British destroyers of the Mohawk class. 1200 w. Int Marine Engng—June, 1908. No. 92378 C.

Propellers.

Results of Further Model Screw-Propeller Experiments. R. E. Froude. Read before the Inst. of Nav. Archts. A report of experimental investigations. 3000 w. Engng—April 24, 1908. Serial. 1st part. No. 92122 A.

Resistance.

Ship-Model Experiments.—A New Method of Research Work on Fluid Resistance and Ship Propulsion. H. Wel lenkamp. Explains method of investigating towing resistance, frictional and air resistance, and propulsion. Ills. 5000 w. Engng—April 24, 1908. No. 92125 A.

Ship Design.

Factors of Safety in Marine Engineering. John Oliver Arnold. Read before the Inst. of Naval Archts. A criticism of methods of design. 2500 w. Engng—April 24, 1908. Serial. 1st part. No. 92126 A.

Steamboats.

New Steamer City of Cleveland. Illustrates and describes a new vessel for service between Detroit and Cleveland, with report of trial trip. 2000 w. Marine Rev —May 7, 1908. No. 92195.

Steam Boilers.

See Oil Firing, under MARINE AND NAVAL ENGINEERING.

Steam Engines.

See Superheating, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steamships.

Egyptian Mail Turbine-Steamers "Heliopolis" and "Cairo." Plates and description of new vessels for service between Marseilles and Alexandria. 2500 w. Engng—April 24, 1908. Serial. 1st part. No. 92124 A.

Steam Turbines.

See Steamships, and Yachts, under MARINE AND NAVAL ENGINEERING.

Steering Gear.

Notes on Steering Gear. Illustrates and describes various types. 2000 w. Int Marine Engng—June, 1908. No. 92377 C.

Submarines.

A Submarine Boat for Sponge Fishing. Capt. Jourdan. Illustrated description. 900 w. Sci Am—May 9, 1908. No. 92187.

Italian Submarines. R. G. Skerrett. An illustrated account of some large submarines. 2200 w. Sci Am Sup—May 23, 1908. No. 92509.

Shipping Submarines Intact to the Philippines. Brief illustrated account of the method of shipping two boats on the deck of the collier "Caesar." 800 w. Sci Am —May 9, 1908. No. 92189.

Tugs.

Thames Conservancy Tug and General Service Steamer Darent. Illustrated description. 900 w. Engr, Lond—May 15, 1908. No. 92570 A.

Yacht Lighting.

Electric Lighting. D. A. Richardson. Illustrates and describes details of the correct plant for boats of various sizes 2500 w. Rudder—May, 1908. No. 92138 C.

Yachts.

The New Turbine Yacht Alexandra. Illustrated description. 700 w. Cassier's Mag—May, 1908. No. 92146 B.

The Twin Screw Steam Yacht Liberty. Benjamin Taylor. Illustrated description of a vessel built for Joseph Pulitzer, of New York. 1800 w. Int Marine Engng—June, 1908. No. 92376 C.

A Clyde-Built Turbine Yacht for America. Benjamin Taylor. Illustrated description of the "Vanadis," built for C. K. G. Billings. 800 w. Int Marine Engng—June, 1908. No. 92375 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

Air-Cooled v. Water-Cooled Engines. A. J. McKinney. Presents the advantages of the air-cooled engine for small light cars. 3500 w. Auto Jour—May 2, 1908. No. 92234 A.

Atholl.

A New Scotch 25 H. P. Car. Illustrated description of a new medium-priced pleasure car. 2000 w. Autocar—May 9, 1908. No. 92343 A.

Carburetters.

See Napier, under AUTOMOBILES.

We supply copies of these articles. See page 658.

Clutches.

Clutches, with Special Reference to Automobile Clutches. Henry Souther. Illustrates and describes various types and their applications. 7500 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92262 D.

Commercial Vehicles.

Commercial Motor Vehicles. Reviews the recently issued report of the trials conducted by the Royal Automobile Club. 4000 w. Engng—May 1, 1908. Serial. 1st part. No. 92247 A.

See also Omnibuses, and Street Cleaning, under AUTOMOBILES.

Daimler.

The De Luca Daimler. Illustrated description of an Italian example of the 17-21 h.p. Daimler. 1500 w. Autocar—May 16, 1908. No. 92551 A.

Electric.

Maxim's Re-Entry into the Electric Field. Brief illustrated description of the new Maxim and Goodridge electric. 1600 w. Automobile—April 30, 1908. No. 92041.

See also Omnibuses, under AUTOMOBILES.

Gears.

The Hope-Maberly Variable Gear. Illustrated description of an ingenious epicyclic mechanism. 2000 w. Auto Jour—May 9, 1908. Serial. 1st part. No. 92344 A.

Electric Clutches and Speed Changing Gears on Combustion-Motor Vehicles (Embrayages et Changements de Vitesse électriques sur les Automobiles à Essence). Illustrates and describes various devices. 3000 w. Génie Civil—April 11, 1908. No. 92418 D.

Hispano-Suiza.

The 1908 Hispano-Suiza Cars. Illustrated detailed description of cars built in Barcelona, Spain. 900 w. Auto Jour—April 25, 1908. Serial. 1st part. No. 92103 A.

Horns.

See Signal Horns, under ELECTRICAL ENGINEERING, COMMUNICATION.

Ignition.

Electric Ignition Devices. S. F. Walker. A plea for greater strength and greater care. 2500 w. Autocar—May 2, 1908. No. 92236 A.

Metallurgique.

The Metallurgique Cars, 1908 Models. Illustrates and describes the special features. 2000 w. Auto Jour—May 16, 1908. Serial. 1st part. No. 92549 A.

Motors.

The Six-Cylinder Automobile. Herbert L. Towle. Considers the relative advantages of four and six-cylinder engines. Ills. 2500 w. Cassier's Mag—May, 1908. No. 92149 B.

The Two-Cycle Question (Beiträge zur Zweitaktfrage). Herr Schwerdtfeger. A discussion of the present status of the two-cycle motor for automobiles. 3000 w. Zeitschr d Mit Motorwagen Ver—April 30, 1908. No. 92466 D.

See also Air Cooling, under AUTOMOBILES.

Napier.

The 80-H.P. Napier Touring Car and Carburettor. Brief description with views of the carburettor. 1800 w. Auto Jour—May 16, 1908. No. 92550 A.

Omnibuses.

The Greenwood and Batley Petrol-Electric 'Bus. Illustrated description. 800 w. Elec Rev, Lond—May 1, 1908. No. 92240 A.

Motor Omnibus Traffic in Paris (Der Pariser Motoromnibusverkehr). Herbert Bauer. Describes the cars used, their maintenance and operation, etc. Ills. 5000 w. Zeitschr d Mit Motorwagen-Ver—April 30, 1908. No. 92465 D.

Road Trains.

Road Traction by Renard Trains (Traccion en los Caminos : Trenes Renard). Francisco J. Casas. An elaborate discussion of the history of road trains, the operation of the Renard train, design, resistance, loads, etc. 5600 w. Ann de Ing Col—April, 1908. No. 92428 D.

Street Cleaning.

An Automobile for Street Sweeping and Sprinkling in Paris (Balayeuse-Arroseuse Automobile de la Ville de Paris). E. Bret. Illustrated detailed description. 4000 w. Serial. 1st part. Génie Civil—April 18, 1908. No. 92419 D.

Testing.

Horse-Power at the Road Wheels. Illustrated description of a machine to test the effective power of any car, with records of four tests. 2000 w. Autocar—May 2, 1908. No. 92235 A.

Tractors.

The Hornsby Chain-Track Tractor. Illustrates and describes a device for traveling over natural ground. 1600 w. Auto Jour—April 25, 1908. No. 92102 A.

The "Caterpillar" Tractor. Illustrates and describes a novel engine invented by David Roberts. The Hornby chain tractor, and its operation. 1700 w. Sci Am—May 16, 1908. No. 92263.

Wheels.

Detachable Rims and Wheels. Illustrated description of various types. 5000 w. Autocar—April 25, 1908. No. 92105 A.

COMBUSTION MOTORS.

Exhaust Mufflers.

Exhaust Mufflers for Gas Engines. H. Addison Johnston. Describes an almost noiseless muffler made by the writer. 1000 w. Power—May 19, 1908. No. 92370.

We supply copies of these articles. See page 658.

Gas Engines.

New Features in Gas-Engine Construction. George W. Malcolm. Illustrates and describes a double-acting tandem machine of unusual type. 2500 w. Am Mach—Vol. 31. No. 22. No. 92633.

Westinghouse Gas Engines. An illustrated article giving information in regard to these engines. 3500 w. Ir Age—April, 30, 1908. No. 92009.

The Westinghouse Horizontal Gas Engine. Gives a summary of some important points, with illustrated description of installations. 6000 w. Ir Trd Rev—April 30, 1908. No. 92040.

The 2000-KW. Gas-Electric Set for the Bessemer Works of the United States Steel Corporation. Illustrated description. 2700 w. St Ry Jour—May 2, 1908. No. 92037.

Tandem Gas Engine at Watson-Stillman Plant. George W. Malcolm. Illustrated description of a machine differing materially from the conventional type. 2200 w. Power—May 5, 1908. No. 92140.

Interesting Gas Engine Cycle Development. Ernest Coler. Illustrates and describes an internal combustion motor having a modified cycle, invented by Robert Miller. 1500 w. Automobile—May 21, 1908. No. 92513.

The Horse Power, Friction Losses and Efficiencies of Gas and Oil Engines. Lionel S. Marks. Explains a proposed new measure of power. 3000 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92260 C.

The Starting of Internal-Combustion Motors (Das Anlassen der Verbrennungskraftmaschinen). P. Meyer. Considers methods and the phenomena of starting two- and four-cycle gas engines. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—April 11, 1908. No. 92480 D.

Researches on the Combustion Process in the Gas Engine (Untersuchungen über den Verbrennungsvorgang in der Gasmaschine). W. Borth. Illustrates the methods and gives the results. 6000 w. Zeitschr d Ver Deutscher Ing—April 4, 1908. No. 92477 D.

See also Exhaust Mufflers, and Ignition, under COMBUSTION MOTORS; Gas Engines, under MARINE AND NAVAL ENGINEERING; and Blowing Engines, under MINING AND METALLURGY, IRON AND STEEL.

Gasoline Engines.

See same title, under MARINE AND NAVAL ENGINEERING.

Gas Power Plants.

Erection and Equipment of Producer Gas Plants. Louis Bendit. Illustrated description of the plant for the Nancy-Helen mines of Cobalt, Ont., showing the economy of the arrangement. 1500 w. Min Wld—May 9, 1908. No. 92215.

Gas Producer By-Products.

Discussion on Mr. F. J. Rowan's Paper on "Ammonia Recovery in Connection with Gas Producers." 5000 w. Jour W of Scotland Ir & St Inst—Feb., 1908. No. 92579 N.

Gas Producers.

The Chief Requisites for Successful Gas-Producer Operation. A. S. Atkinson. Calls attention to the need of skill in the operator, the importance of the vaporizer, etc. 1800 w. Power—May 12, 1908. No. 92231.

Producer Gas for Engine Use: Its Manufacture and Characteristics. W. B. Tuttle. Abstract of a paper read before the S.-W. Elec. & Gas Assn. Deals mainly with gas producers. 1200 w. Elec Ry Rev—May 9, 1908. No. 92224.

Test of a Small Suction Gas Producer Plant. H. B. MacFarland. Considers the requirements of a producer, describes the Atkinson automatic suction-gas producer and its operation, and describes tests made to determine efficiency, reliability and adaptability. Ills. Discussion. 13000 w. Jour W Soc of Engrs—April, 1908. No. 92319 D.

See also Open Hearth, under MINING AND METALLURGY, IRON AND STEEL.

Gas Turbines.

See Turbines, under STEAM ENGINEERING.

Ignition.

Construction of a Spark Coil. F. C. Mason. Directions for building such a coil, with illustrations. 600 w. Elec Wld—May 2, 1908. No. 92006.

Location of Gas Engine Igniters. M. R. Wells. Gives indicator diagrams showing the effect of different locations. 1000 w. Power—May 19, 1908. No. 92372.

Hints on the Causes of the Failure of Electrical Ignition. Sydney F. Walker. Discusses failures due to want of strength and want of attention. 2000 w. Gas Engines—May, 1908. No. 92136.

Oil Engines.

See Gas Engines, under COMBUSTION MOTORS; and Air Compressors, under POWER AND TRANSMISSION.

Producer Gas.

See Gas Producers, under COMBUSTION MOTORS.

HEATING AND COOLING.

Air Liquefaction.

Tests of a Liquid Air Plant. C. S. Hudson and C. M. Garland. An illustrated description of apparatus used and tests made at the laboratory of the University of Illinois, giving results. 3800 w. Bul Univ of Ill, No. 21—March 1, 1908. No. 92583 N.

We supply copies of these articles. See page 658.

Fans.

The Performance of Fan Blowers. Walter B. Snow. Gives rules, formulæ and tables for computing the required power to drive them, and their capacity. 7000 w. Power—May 19, 1908. No. 92373.

Gas Heating.

Heating a Swimming Pool with Gas. A plant installed in the University Club at Pittsburgh is illustrated and described. 2000 w. Met Work—May 23, 1908. No. 92527.

Hot-Air Heating.

The Merits of the Warm Air Furnace. Charles S. Prizer. Presidential address before an association organized to advance furnace heating. 3500 w. Met Work—May 16, 1908. No. 92303.

Hot-Blast Heating System for a Hospital. Illustrated description of the equipment of the new Freedmen's Hospital building, Washington, D. C., with special reference to temperature control. 1000 w. Heat & Vent Mag—May, 1908. No. 92615.

Heating and Ventilation of the First Church of Christ, Scientist, Boston, Mass. Charles L. Hubbard. Explains the conditions imposed, and describes the plant. Ills. 1500 w. Met Work—May 9, 1908. Serial. 1st part. No. 92185.

Hot-Water Heating.

The Choice of Temperature Difference Between the Riser and Return Mains of a Rapid-Circulation Hot-Water Heating System with Double or Single Main (Die Wahl der Temperaturdifferenz zwischen der Zu- und Rückleitung einer Warmwasserheizung und einer Schnellumlaufheizung beim Zweirohrsysteme und beim Einrohrsysteme). H. Roose. 4000 w. Gesundheits-Ing—April 4, 1908. No. 92452 D.

Industrial Buildings.

Heating Systems for Mills. Notes from a paper by A. G. Hosmer, read before the Nat. Assn. of Cotton Mfrs. Discusses direct radiation, the indirect or hot-blast system, and forced hot-water circulation. 2800 w. Eng Rec—May 9, 1908. No. 92203.

Piping.

See Steam Pipes, under STEAM ENGINEERING.

Refrigeration.

Calcium Chloride. S. W. Calhoun. Considers some of the advantages and disadvantages of its use in place of salt for refrigeration. 1000 w. Ice & Refrig—May, 1908. No. 92154 C.

Pipe-Line Refrigeration for General Service. Jos. H. Hart. Discusses its mechanical difficulties and their possible removal. 2000 w. Engineering Magazine—June, 1908. No. 92629 B.

Steam Heating.

Some Results of Steam Heating from a Central Station. James A. White. Presents results of this system, explaining its advantages. Ills. 2200 w. Cent Sta—May, 1908. No. 92269.

Ventilation.

How Cave Air is Used to Regulate the Temperature of a House. C. H. Claudy. Illustrated description of a house in Virginia, built on a hill above the caverns of Luray, and deriving its air through an airshaft from the caverns. 1200 w. Sci Am—May 16, 1908. No. 92264.

See also Hot-Air Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Characteristics of Centrifugal Pumps and Their Derivation from the Results of Tests (Charakteristische Eigenschaften der Kreiselpumpe und ihre Ermittlung aus Versuchsergebnissen). Johannes Bente. A discussion of the correct interpretation of test results. Ills. 2000 w. Die Turbine—April 5, 1908. No. 92470 D.

See also Turbines, under STEAM ENGINEERING.

Pumping Plants.

Modern Fire Pumping Stations for Brooklyn, New York. Explains the system of high-pressure, and illustrates and describes one of the stations. 2500 w. Ind Wld—May 4, 1908. No. 92061.

See also Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL; and Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

Rotary and Steam Fire Pumps. Ezra E. Clark. Reviews the development of pumps, and their adoption for the protection of mills and factories, their construction and installation. Ills. 6000 w. Ins Eng—May, 1908. No. 92574 C.

Turbines.

Hydraulic Turbines of Maximum Output (Note sur les Turbines hydrauliques de Rendement maximum). M. Bonnifet. A mathematical and theoretical paper discussing the design of turbines to obtain maximum power under any given conditions. Ills. 10000 w. Revue de Mécan—April 30, 1908. No. 92412 E + F.

See also same title, under STEAM ENGINEERING.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

The Factor of Safety in Ball Bearings. G. T. Rennerfelt. Shows the advantage of four balls, and gives diagrams and description of bearing designs. 1500 w. Am Mach—Vol. 31. No. 19. No. 92158.

We supply copies of these articles. See page 658.

Ball Bearings in the Construction of Machine Tools with Special Reference to the Bearings of Lathe Spindles (Die Kugellager im Werkzeugmaschinenbau unter besonderer Berücksichtigung der Drehbankspindellagerungen). August Bauschlicher. Illustrates a number of applications. 3000 w. Serial. 1st part. Zeitschr f Werkzeug—April 5, 1908. No. 92460 D.

Chains.

See Chain Making, under MACHINE WORKS AND FOUNDRIES.

Clutches.

See same title, under AUTOMOBILES.

Graphical Charts.

The Construction of Graphical Charts John B. Peddle. Explains how charts are plotted from equations by analyzing, substituting values and selecting scales. Gives examples. 7500 w. Am Mach—Vol. 31, No. 20. No. 92272.

Piston Rings.

Piston Rings of Uniform Strength. W. Osborne. A brief discussion of the problem, with drawings. 1400 w. Am Mach—Vol. 31, No. 19. No. 92159.

Springs.

The Design of Springs for Gas Engine Valves. F. E. Whittlesey. Considers only compression springs of round steel wire. 1000 w. Mach, N Y—May, 1908. No. 92093 C.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

German Methods of Marine Boiler Construction. Walter Mentz. Describes the machinery used and the shop operations. Ills. 2000 w. Boiler Maker—May, 1908. Serial. 1st part. No. 92090.

Brass Founding.

The Method Now Used for Coloring Plumbers' Yellow Brass Goods Red. Explains the method. 1200 w. Brass Wld—May, 1908. No. 92526.

Production of the "Old Brass" Finish. Explains the treatment of cast brass, and of brass plated goods. 1200 w. Brass Wld—May, 1908. No. 92525.

The Manufacture of Brass in Early Times and the Formation of the First Brass Trust. Erwin S. Sperry. A review of early history. Ills. 3500 w. Brass Wld—May, 1908. No. 92524.

Case Hardening.

The Gas Process of Case-Hardening. J. F. Springer. Illustrated description of this process of gas carbonization, developed by Adolph W. Machlet. 2500 w. Ir Age—May 28, 1908. No. 92650.

Castings.

Iron and Castings for Piston-Ring Blanks. A. Manchester. Suggestions for small-diameter piston rings. 1200 w. Am Mach—Vol. 31, No. 18. No. 92001.

The Production of Solid Castings by the Use of Deoxydizing Fluxes (Herstellung dichter Güsse durch desoxydierende Zuschläge). Th. Geilenkirchen. A discussion of the use of ferro-manganese, ferro-silicon, aluminium, natrium, magnesium, etc., with data on the results obtained. 2500 w. Stahl u Eisen—April 22, 1908. No. 92441 D.

Chain Making.

Chains and Chain Making. James H. Baker. Reviews the history of chain-making and describes the process, giving information relating to their strength, reliability, etc. Discussion. Ills. 6000 w. Pro Engrs' Soc of W Penn—May, 1908. No. 92613 D.

Core Boxes.

Difficult Metal Core-Box Work. Ethan Viall and J. J. Voelcker. Illustrates and describes methods used in the manufacture of brass goods and high class plumbing fixtures. 2500 w. Am Mach—Vol. 31 No. 20. No. 92273.

Cores.

Core Binders. E. D. Frohman. Read before the Pittsburgh Found. Assn. Considers the various raw materials used in the manufacture of cores. 2000 w. Ir Age—May 14, 1908. No. 92268.

Cupolas.

Operation and Care of the Cupola. W. S. Anderson. Modern practice is discussed. 2000 w. Foundry—May, 1908. No. 92051.

The Modern Cupola (Der moderne Kupolofen). Karl Schiel. A discussion of modern cupola practice, referring to fuel, air blast, etc. 2800 w. Stahl u Eisen—April 29, 1908. No. 92443 D.

Cutting Metals.

Cutting Metals with Oxygen. Jacques Boyer. Illustrated description of the German Oxhydric Co.'s process. 900 w. Sci Am—May 9, 1908. No. 92186.

Drilling Machines.

A New Variable-Speed Sensitive Drill Press. Louis W. Rawson. Describes a multiple-spindle drill used at the Washburn Shops, Worcester, Mass. Ills. 2000 w. Jour Worcester Poly Inst—May, 1908. No. 92578 C.

Forging.

Drop and Stamp Forgings. Joseph Horner. Reviews the development of stamping processes, discussing materials and their treatment, etc. Ills. 3000 w. Mach, N Y—May, 1908. No. 92095 C.

Forging Presses.

A Large Flanging Press for Boiler Sheets. William J. Withem. An illustrated description of an hydraulically operated press having only two supports for the head and cylinders. 500 w. Am Mach—Vol. 31, No. 18. No. 92000.

We supply copies of these articles. See page 658.

Foundries.

The Foundry Plant of the Deutz Gas Engine Works (Die Giessereianlagen der Gasmotoren-Fabrik Deutz). E. Neufang. Describes the equipment and methods. Ills. 2800 w. Serial. 1st part. Stahl u Eisen—April 1, 1908. No. 92435 D.

Foundry Practice.

Milling Machine Framing. A. C. Brock. (Prize paper.) Describes the making of the pattern, core-boxes and mold. 3500 w. Mech Wld—May 1, 1908. No. 92246 A.

Facings and Facing Sands in the Foundry. Walter J. May. Information regarding the preparation and use of facing sands. 1200 w. Prac Engr—April 24, 1908. No. 92108 A.

Gear Cutting.

The Cincinnati Gear Cutter. Illustrated description of the new line of gear cutters and their operation. 1200 w. Ir Age—April 30, 1908. No. 92008.

Gun Making.

Big Gun Making in Sweden. An illustrated account of works at Bofors, Sweden, the built-up guns made, and other information. 2000 w. Engr, Lond—May 1, 1908. No. 92250 A.

Lapping Machines.

A Lapping Machine of Novel Construction. Illustrated description of a machine for finishing cylindrical surfaces by means of reciprocating laps which are automatically adjusted. 800 w. Am Mach—Vol. 31, No. 21. No. 92394.

Lathes.

The New Morris Geared-Head Lathe. Illustrated detailed description. 4000 w. Ir Age—May 28, 1908. No. 92651.

A Double-Ended Spindle Boring Lathe. W. F. Groene. Illustrated detailed description of a powerful machine. 1000 w. Am Mach—Vol. 31, No. 19. No. 92155.

An Engine Lathe with Many Novel Features. Illustrates a lathe for using high-speed steel, which has many new features. Designed by W. L. Shellenbach. 5000 w. Am Mach—Vol. 31, No. 22. No. 92634.

Levels.

Precision Levels and Accurate Leveling. Articles on setting boring-mill uprights with a novel form of level, and leveling planers properly for accurate work. Ills. 2000 w. Am Mach—Vol. 31, No. 18. No. 91996.

Machine Tools.

See Ball Bearings, under MACHINE ELEMENTS AND DESIGN.

Molding.

Method of Molding a Dome Casting. W. W. McCarter. Illustrated description of a novel yet simple method. 800 w. Foundry—May, 1908. No. 92052.

Molding a Narrow Foundation Plate. Jabez Nall. Illustrated description of an economical method. 1200 w. Foundry—May, 1908. No. 92053.

Molding Machines.

Machine-Molded Stove Plate. Illustrates and describes modern development in the art of molding stove castings. 2500 w. Foundry—May, 1908. No. 92049.

A French Universal System of Machine Molding. Frank C. Perkins. Illustrated description. 800 w. Sci Am—May 16, 1908. No. 92265.

Shop Design.

Location, Arrangement and Construction of Manufacturing Plants. George M. Brill. An illustrated discussion of features of importance applicable to a variety of manufacturing plants. Discussion. 8000 w. Jour W Soc of Engrs—April, 1908. No. 92318 D.

Shop Hygiene.

Improvements in Shop Hygiene (Améliorations dans l'Hygiène des Ateliers). Albert Berthiot. A review of the improvements effected under the French factory laws. 2000 w. Rev d'Econ Indus—April 16, 1908. No. 92400 D.

Shop Practice.

Machining Multiple-Throw Crankshafts. J. C. Spence. An illustrated description of the method developed by the Norton Grinding Co. aim at economical production. 1200 w. Am Mach—Vol. 31, No. 22. No. 92635.

The Product and Methods of European Locomotive Works. Charles R. King. The present number deals with German works and their product, describing new tools and processes, and showing advancement on American design. Ills. 5000 w. Engineering Magazine—June, 1908. Serial. 1st part. No. 92625 B.

Shops.

A Study of the Michigan Factory Systems. Berne Nadall. Illustrated article describing the Packard plant, at Detroit, plants at Pontiac, Mich., the Oakland car, and notes on the Ford plant. 3000 w. Automobile—May 14, 1908. No. 92284.

Shop Ventilation.

Exhaust Fan Installations (Impianti di Aspirazione). Siegfried Herzog. Has particular reference to the removal of dust in the grinding trades in the first instalment. Ills. 2100 w. Serial. 1st part. L'Indus—April 19, 1908. No. 92423 D.

Tools.

See Tool Steels, under MATERIALS OF CONSTRUCTION.

Welding.

Oxy-Hydrogen Welding. Frank Koester. Illustrates and describes the production of the oxy-hydrogen mixture and the welding process. 2500 w. Elec Wld—May 9, 1908. No. 92177.

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MATERIALS OF CONSTRUCTION.

Alloys.

White Brass and White Bronze. C. U. Prum. An explanation of the difference between these alloys. 1500 w. Mech Wld—April 24, 1908. No. 92100 A.

Alloy Steels.

See Rare Metals, under MINING AND METALLURGY, MINOR MINERALS.

Metallography.

The Gas Occluded in Steel (Gaz Occlus dans les Aciers). M. G. Belloc. Gives results of extensive investigations to determine its character and amount. Bul Soc d'Encour—April, 1908. No. 92476 E + F.

The Principles of Microscopic Metallography (Principios de la Metalografia microscopica). Luis Daunis. Discusses the preparation of specimens, the use of the microscope and gives a brief review of the metallography of steel. Ills. 2500 w. Rev Tech Indus—March, 1908. No. 92426 D.

Steel.

Hardness in Steel and Its Variations. Albert F. Shore. An explanation of different kinds of hardness as measured by the scleroscope and the causes. 3500 w. Am Mach—Vol. 31, No. 18. No. 91998.

Practical Experiments in Steel. Charles L. Huston. A report of experiments made to obtain knowledge of the internal structure of boiler plate steel. Ills. 2000 w. Jour Fr Inst—May, 1908. No. 92593 D.

Tool Steels.

Annealing, Hardening and Tempering Tools. James Steele. Suggestions for the treatment of tool steel. 1200 w. Am Mach—Vol. 31, No. 18. No. 91997.

MEASUREMENT.

Hardness.

Researches on Hardness and Hardness Testing (Untersuchungen über Härteprüfung und Härte). Eugen Meyer. A record of extensive investigations on the Brinell method. Ills. 6500 w. Serial 1st part. Zeitschr d Ver Deutscher Ing—April 25, 1908. No. 92483 D.

See also Steel, under MATERIALS OF CONSTRUCTION.

Pyrometry.

A New Radiation Pyrometer. Charles Burton Thwing. Describes an instrument for the accurate measurement of the higher temperatures. 1500 w. Jour Fr Inst—May, 1908. No. 92592 D.

Telescope Method.

The Mensuration of Small Angles and Minute Lengths. John G. A. Rhodin. On the advantages of using the telescope and scale, and the applications of the method. 3000 w. Engr, Lond—April 24, 1908. No. 92128 A.

Testing Methods.

The Shock Test on Nicked Bars (L'Essai au Choc sur Barreaux entailles). H. C. Ehrensberger. An elaborately illustrated discussion, giving the results of tests of the method, presented before the German Association for Testing Materials. 6000 w. Rev de Métal—April, 1908. No. 92497 E + F.

POWER AND TRANSMISSION.

Air Compressors.

Air Compressors. On the compression of air, and the use of air compressor diagrams. 2500 w. Mech Wld—May 15, 1908. No. 92560 A.

A Variable-Volume Air Compressor. H. V. Haight. Illustrated description of an unloading device which varies air delivered by quarter-loads and maintains full compound efficiency. 1400 w. Am Mach—Vol. 31, No. 18. No. 91999.

A High-Speed Oil-Engine Air Compressor: Features of Design and Results of Tests. Illustrates and describes the Mietz & Weiss oil-engine and its application for driving a direct-connected air-compressor. 2000 w. Eng News—May 7, 1908. No. 92181.

Belt Driving.

The Determination of the Loss of Power in Belts (Bestimmung von Riemenverlusten). F. Niethammer and R. Czepek. Describes tests and gives results. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—April 25, 1908. No. 92484 D.

The Efficiency of Belt Driving (Ueber den Wirkungsgrad von Riementrieben). Karl Kobes. A mathematical discussion. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—April 17, 1908. No. 92457 D.

Chain Driving.

Power Transmission by Chain. Edward T. Flax. Illustrates and describes special applications. 3500 w. Cassier's Mag—May, 1908. No. 92150 B.

The Proper Way to Use Link-Belt. Staunton B. Peck. Considers the best conditions and how to run the chain. 1000 w. Am Mach—Vol. 31, No. 20. No. 92271.

Costs.

Steam-Electric versus Hydro-Electric Power. Henry Docker Jackson. Discussion of features that should control the selection of a source of power. 5000 w. Power—May 19, 1908. No. 92371.

Electric Driving.

Electric Power in Iron and Steel Mills. W. Edgar Reed. On the applications made of electric power, and the problems connected, with description of a few installations. Discussion. Ills. 9000 w. Pro Engrs' Soc of W Penn—April, 1908. No. 92257 D.

We supply copies of these articles. See page 658.

Electricity Applied to Rolling Mills (L'Electricité appliquée aux Trains de Laminoirs). Reviews technical considerations and gives the results obtained in European plants. Ills. 5500 w. All Indus—April, 1908. No. 92414 D.

See also Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Lubrication.

Economical Lubrication of Large Plants. William M. Davis. Considers how to secure economical engine lubrication without lowering the efficiency of the plant. Discussion. 8000 w. Jour Assn of Engng Socs—April, 1908. No. 92588 C.

Mechanical Plants.

Mechanical Plant of the United States Express Company's Building, New York City. Brief description of the building, with detailed description of the plant for heating, lighting, power and ventilation, and a refrigerating plant. 5000 w. Eng Rec—May 16, 1908. No. 92314.

Power Plants.

The Steam Turbine Power Plant of the Pacific Mills. Illustrated description of a plant for large textile mills. 1500 w. Eng Rec—May 23, 1908. No. 92539.

The Power Plant of the American Biscuit Company, San Francisco. Alfred H. Potbury. Brief description of a successful private plant. 1000 w. Eng Rec—May 9, 1908. No. 92205.

See also Ash Handling, under TRANSPORTING AND CONVEYING.

Turbo-Compressors.

Turbo-Compressors for Blast Furnaces (Ueber Hochofen-Turbinengebläse). P. Langer. Illustrates and describes the various types. 1200 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 10, 1908. No. 92471 D.

See also Turbines, under STEAM ENGINEERING.

STEAM ENGINEERING.

Boiler Efficiency.

Some Results Due to Improvement in Boiler and Furnace Design. A. Bement. A report of results of tests made at Chicago, and Cedar Rapids, Ia., with comparison, and general discussion. Ills. 27000 w. Jour W Soc of Engrs—April, 1908. No. 92320 D.

Boiler Fittings.

Some Notes on the Boiler Blow-off. Warren H. Miller. Information relating to the design of blow-offs and their dangers, illustrating by example. 2000 w. Eng Rec—May 9, 1908. No. 92209.

Boiler Furnaces.

Automatic Damper Regulators. W. H. Wakeman. Explains the principles by which such regulators operate. Ills. 1500 w. Elec Wld—May 2, 1908. No. 92007.

Furnace Design in Relation to Fuel Economy. E. G. Bailey. Considers losses in the operation of steam boilers, giving data of tests. General discussion. 11000 w. Jour Assn of Engng Socs—April, 1908. No. 92587 C.

Boiler Management.

Care of the Horizontal Tubular Boiler. M. Kennett. Suggestions for the management. Ills. 2500 w. Power—May 12, 1908. No. 92232.

Fuel Economics and Steam Generation. W. Francis Goodrich. Discusses aspects of fuel economy of interest to steam users such as machine firing, hand firing, smoke prevention, etc., giving details of tests. 7500 w. Pub Works—April, 1908. No. 92640 B.

Boiler Waters.

See Feed-Water Heating, and Water Meters, under STEAM ENGINEERING.

Engine Failures.

Failure of a Cross-Compound Engine. W. H. Wakeman. Analysis of the accident and conclusion concerning the cause. Ills. 1500 w. Power—May 12, 1908. No. 92228.

Engine Lubrication.

See Lubrication, under POWER AND TRANSMISSION.

Engines.

A Large Twin-Tandem Compound Direct-Connected Reversing Mill Engine. Illustrated description of a noteworthy engine. 3300 w. Ir Trd Rev—May 7, 1908. No. 92160.

4000-Horse-Power Engine at the Central Electric Generating Station, Brussels. Illustrations and report of tests. 3000 w. Engng—May 1, 1908. No. 92248 A.

The Most Powerful of All Steam Engines. James Tribe. Illustrates and describes features involved in the design and construction of a large reversible rolling-mill engine at the Carnegie Steel Works. 2200 w. Am Mach—Vol. 31, No. 20. No. 92270.

The Actual State of Heat Engines (Consideraciones sobre el Estado actual de los Motores termicos). Carlos Barutell. The first part of the serial begins a discussion of steam engines. 3000 w. Serial. 1st part. Energia Elec—April 25, 1908. No. 92431 D.

Engine Troubles.

Engine Knocks—Their Causes and Remedies. Hubert E. Collins. Analyzes these troubles, giving directions for their prevention or cure. Ills. 3000 w. Power—May 5, 1908. No. 92142.

Feed-Water Heating.

Tests on Live Steam Feed Water Heating. Sydney B. Bilbrough, *Transvaal Inst. of Mech. Engrs.* An account of experiments conducted in South Africa to

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observe the heat transmission through boiler plate under varying conditions. 3500 w. Power—May 12, 1908. No. 92230.

Fuels.

The Calorific Power of Fuels. F. N. Morton. Suggests a definition which, when the calorific value is stated in terms of British thermal units, will admit of no ambiguity. 1800 w. Stevens Ind—April, 1908. No. 92585 D.

Liquid Fuel. W. H. Booth. Discusses questions in connection with oil-burning systems. 2000 w. Power—May 12, 1908. No. 92233.

Fuels. Charles L. Hubbard. Brief review of various grades of coal and other fuels used for the generation of steam. 2000 w. Elec Rev, N Y—May 16, 1908. No. 92306.

Coal from the Standpoint of the Engineer. George H. Ashley. Discusses the elements of coal, its heating value, purchase, use, etc. 2800 w. Sib Jour of Engng—May, 1908. No. 92614 C.

The Best Kind of Coal for a Factory. E. G. Bailey. Read before the Nat. Assn. of Cotton Mfrs. Calls attention to things a manufacturer should know to secure the most economical fuel. 3000 w. Sci Am Sup—May 9, 1908. No. 92192.

The Purchase of Coal on a Scientific Basis. John B. C. Kershaw. Condemns methods in present use and advocates a system of valuation based on the heat unit content. 3300 w. Cassier's Mag—May, 1908. No. 92151 B.

Wood as Fuel—Notable Wood Burning Plants. William D. Ennis. Discusses the calorific values of woods; the best kind for steam-plant uses, etc. Ills. 4000 w. Power—May 26, 1908. No. 92595.

Fuel Testing.

Determination of the Value of Coal for Steaming Purposes. Richard K. Meade. Describes methods used in the analysis of coal, with formulæ and terms. 1800 w. Min Sci—May 14, 1908. Serial. 1st part. No. 92337.

Indicators.

Indicators and Indicator Diagrams. W. A. Tookey. Abstract of a paper before the Assn. of Engrs. in Charge. Remarks on the value of the records, with illustrations of indicators and descriptions of details. 3500 w. Mech Engr—May 1, 1908. Serial. 1st part. No. 92238 A.

Injectors.

Points on the Injector. P. E. Capraro. Considers the selection of an injector, their use, and troubles. Ills. 1600 w. Mech Wld—May 1, 1908. No. 92245 A.

Pressure Gauges.

Hydrostatic Pressure Gauges in Plant Management (Hydrostatic Druckmesser als Betriebskontrollapparate). Paul de Bruyn. Describes the various uses of these recording gauges in steam plants and steel works. Ills. 2400 w. Serial. 1st part. Oest Zeitschr f Berg- u Hüttenwesen—April 18, 1908. No. 92446 D.

Steam Pipes.

Draining of Steam and Water Pipes. H. A. Jahnke. Explains simple methods of making connections in order to avoid pocketing, water hammer and freezing. Ills. 1200 w. Power—May 26, 1908. No. 92597.

The Capacity of Pipes for Conveying Steam. E. C. Sickles. Explains the principles underlying the flow of steam in pipes, giving charts from which may be read the capacity with given pressure drop, or vice-versa. 1700 w. Power—May 26, 1908. No. 92596.

Stokers.

Mechanical Stokers. John Egerton Barnes. Abstract of a paper read at Inst. of Mech. Engrs. Grad. Assn. Describes features of the principal types in use, discussing their advantages and drawbacks. 3500 w. Elec Engr, Lond—May 1, 1908. No. 92239 A.

Superheating.

Use of Superheated Steam with Marine Engines. Felix F. T. Godard. Read before the Inst. of Naval Archts. Information concerning the trials that have been made and the results. Ills. 2000 w. Mech Engr—April 24, 1908. No. 92107 A.

The Thermal Properties of Superheated Steam. R. C. H. Heck. Considers the best available data in regard to the specific heat of superheated steam, the value and variation, and derives a convenient table for general use. 6500 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92261 C.

See also Locomotive Superheaters, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Thermodynamics.

Thermodynamics of Pressure Drop or Throttling. R. C. H. Heck. An explanation of what takes place whenever the steam is throttled or wire-drawn. 3800 w. Power—May 26, 1908. No. 92598.

Turbine Plants.

See Power Plants, under POWER AND TRANSMISSION.

Turbines.

The Rateau Steam-Turbine. Illustrated detailed description. Plates. 4000 w. Engng—May 15, 1908. No. 92562 A.

Exhaust Steam Turbines. P. J. Mitchell. Explains the chief features of the Rateau system and describes plants installed. 4500 w. Jour W of Scotland Ir & St Inst—Feb., 1908. No. 92580 N.

The Melms and Pfenninger Steam Turbine (Die Dampfturbine System

Melms & Pfenninger). Oskar Peschke. An illustrated description of this turbine which combines features of both the impulse and reaction types. 2500 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 18, 1908. No. 92472 D.

The Westinghouse Double-Flow, Impulse-Reaction Turbines at the Brunot Island Power Station of the Pittsburgh Railways Co. Describes a recent extension of this plant and the new machinery installed. Ills. 3300 w. Eng News—May 28, 1908. No. 92639.

Construction Details of a Reaction Turbine. Henry E. Schmidt. Deals with blade material and height; clearance, radially and axially; the design of balance pistons and steam passages, etc. Ills. 2500 w. Power—May 19, 1908. No. 92639.

The Efficiency of Steam Turbines. F. A. Lart. Reviews the mechanical means of utilizing the energy of the steam and presents the advantages of the Field-Morris aërated steam system. 6000 w. Cassier's Mag—May, 1908. No. 92148 B.

The Theory of Rotating Guides in Turbines (Zur Theorie rotierender Umsetzer bei Turbogeneratoren und Turbomotoren). J. Novak. Discusses all classes of turbine machinery, gas, water and steam turbines, and centrifugal pumps, blowers, and compressors. Ills. 2000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 30, 1908. No. 92473 D.

Valve Gears.

Piston Valves. Discusses the objections to piston valves and their advantages. Ills. 2000 w. Prac Engr—May 8, 1908. Serial. 1st part. No. 92346 A.

Water Meters.

Lea's Water Recorder. Illustrated description of a recording instrument of general application, but especially suitable for the measurement of boiler feed water and the discharges from air pumps. 1500 w. Elect'n, Lond—May 8, 1908. No. 92354 A.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

See Hoisting, under TRANSPORTING AND CONVEYING.

Ash Handling.

See Trestles, under CIVIL ENGINEERING, BRIDGES.

Coal Handling.

Coal Handling in Austrian Harbors (Der Kohlenumschlag an der Oesterreichischen Seeküste). Hermann R. v. Littrow. Illustrates and describes the dock arrangements and coal handling facilities of the various harbors through which coal is imported with information as to the extent of the coal trade, etc. Ills. 2000 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—April 3, 1908. No. 92455 D.

Conveyors.

Conveyor System at the New Kleinfontein Mill. Edward J. Way. Illustrated description of labor-saving apparatus installed in South Africa. 4000 w. Eng & Min Jour—May 2, 1908. No. 92075.

Cranes.

A Tower Crane for the Bremer Vulkan Shipbuilding Yard. Illustrated description. 1000 w. Engr, Lond—April 24, 1908. No. 92130 A.

Electrical Cranes for Dock and Harbor Work. Illustrated description of a portion of the equipment of 134 portal cranes at the Kuhwaeder Dock, Hamburg. 900 w. Elec Rev, Lond—May 8, 1908. No. 92350 A.

A Window-Cleaning Traveler for the Carnegie Library, Pittsburg, Pa. Explains the methods adopted for the protection of the books in a smoky city, and gives illustrated detailed description of the arrangements for cleaning the hermetically sealed windows. 3500 w. Eng Rec—May 9, 1908. No. 92208.

See also Hoisting, under TRANSPORTING AND CONVEYING.

Dock Machinery.

See Coal Handling, and Cranes, under TRANSPORTING AND CONVEYING.

Hoisting.

The Transformation in Hoisting Machinery due to Electricity (Die Umgestaltung der Hebemaschinen durch die Elektrotechnik). Prof. Kammerer. Considers cranes, aerial tramways and electric hoists. Ills. 3000 w. Serial. 1st part. Elektrotech Zeitschr—April 23, 1908. No. 92491 D.

Ore Handling.

Modern Ore Handling Machinery. Walter G. Stephan. Illustrates and describes types of machinery used, and states their advantages in reducing cost. 4000 w. Ir Trd Rev—May 14, 1908. No. 92283.

MISCELLANY.

Aeronautics.

The Cornu Helicopter. An illustrated article describing how this novel type of flying machine was developed. 2500 w. Sci Am Sup—May 16, 1908. No. 92267.

The Record Flight of the Delagrange Aeroplane. An illustrated account of the flight on April 11th, when it remained in the air 9¼ minutes, and covered about 4 miles. 800 w. Sci Am—May 11, 1908. No. 92190.

The Actual State of Aviation (L'Etat actuel de l'Aviation). G. Espitallier. The

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first part of the serial is mainly historical. Ills. 3000 w. Serial. 1st part. Génie Civil—April 4, 1908. No. 92417 D.

The Present Status of Aerial Navigation (Der gegenwärtige Stand der Luftschiffahrt). Carl Steiger. A critical study of present air ship design. Ills. 3000 w. Serial. 1st part. Schweiz Bau—April 4, 1908. No. 92449 D.

Air Resistance.

Experimental Researches on the Resistance of the Air Carried Out at the Eiffel Tower (Recherches expérimentales sur la Résistance de l'Air exécutées à la Tour Eiffel). G. Eiffel. Describes the apparatus used and gives the results. Ills. 2400 w. Mem Soc Ing Civ de France—Feb., 1908. No. 92405 G.

Clocks.

A Clock with a Forty-foot Dial. Illustrated description of a clock on the Jersey City side of the North River in which the hand moves 23 inches a minute. 1500 w. Am Mach—Vol. 31, No. 21. No. 92393.

Cyclometers.

Making the Veeder Cyclometer. Describes methods used in printing, threading, marking and testing cyclometers and odometers. Ills. 1100 w. Am Mach—Vol. 31, No. 92395.

Glass Making.

The Colburn Window-Glass Machine. An illustrated description of a machine for drawing window glass continuously in any width. 2500 w. Sci Am Sup—May 16, 1908. No. 92266.

Minting Machinery.

Mechanical Equipment of the Ottawa Mint. A. H. W. Cleave. Illustrated description. 6000 w. Can Elec News—May, 1908. No. 92196 C.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

See Fuel Testing, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Coal Cutting.

Tests of a Sullivan Coal Cutting Machine at the Göttelborn Colliery (Versuche mit einer Schrämmaschine der Sullivan Machinery Company auf dem Königlichen Steinkohlenbergwerk Göttelborn). Dr. Hoernecke. Describes the tests and gives results. 2000 w. Glückauf—April 25, 1908. No. 92448 D.

Coke.

Arsenic-Free Gas Coke. H. O'Conner and Dr. Drinkwater. Abstract of a paper read before the Roy. Scottish Soc. of Arts. Investigations made on account of the scare of arsenic poisoning in beer, with a description of the test of fuels used in brewing, and method of treating coke. 2000 w. Ir & Coal Trds Rev—April 24, 1908. No. 92133 A.

Coke Ovens.

Transition in Coke Making. William L. Affelder. Illustrates and describes some new forms of ovens and machines for quenching and drawing coke and leveling coal in ovens. 4000 w. Mines & Min—May, 1908. No. 92031 C.

The "Simon-Carves" Vertical Flued By-Product Coke Oven. Illustrates and describes both the regenerative and non-regenerative types, with comparison. 2000 w. Ir & Coal Trds Rev—May 1, 1908. No. 92251 A.

See also Refractory Materials, under MISCELLANY.

Coking.

The Effect on Coal of Water and Fine Crushing. H. M. Chapman and Edwin Barnhart. Reports tests made which show a lessened weight of wet and fine coal. 1200 w. Ir Age—May 7, 1908. No. 92163.

Coking By-Products.

The Recovery of By-Products from Coke Ovens. Reviews a paper on this subject by W. H. Coleman, recently read at Manchester, Eng. 2300 w. Engr, Lond—May 8, 1908. No. 92359 A.

The Marchal Apparatus for Estimating the Value of By-Products in Fuel. From *Revue Univ. des Mines.* Illustrated description of the apparatus and its operation. 1500 w. Col Guard—May 8, 1908. No. 92355 A.

Coking Plants.

Some Recent Coking Plants. W. Archie Weldin. Illustrates and describes the recent plants of the H. C. Frick Coke Co. which involve various unusual features. 5000 w. Eng Rec—May 23, 1908. No. 92540.

Starting By-Product Coke Oven Plant. A. Thau, in *Gluckauf.* Illustrates and describes the starting of the plant. 5000 w. Ir & Coal Trds Rev—May 8, 1908. No. 92364 A.

Electric Power.

Electrical Installation at Tribley Pit. Illustrates and describes an installation for colliery purposes. 2000 w. Elect'n—May 15, 1908. No. 92559 A.

Electrically Operated Coal Mines in Alabama. Frank C. Perkins. Illustrates and describes details of operation in the

Birmingham district. 1500 w. Min Wld —May 2, 1908. No. 92085.

Explosions.

Dinas Main Colliery Explosion. Information concerning this explosion in the Swansea district, Wales, in Dec., 1907, as taken from the Home Office Report. 4000 w. Col Guard—May 15, 1908. No. 92561 A.

The Hanna, Wyoming, Mine Disaster. R. L. Herrick. Illustrated account of the two explosions, the probable causes, and the conditions leading up to them. 3200 w. Mines & Min—May, 1908. No. 92028 C.

Mine Dust.

Report of the French Commission on Explosives and Coal Dust. L. Didier. Trans. from *Bul. Soc. Industrie Minerale.* 1200 w. Col Guard—April 24, 1908. No. 92120 A.

Dust Made in Mining Coal. C. E. Scott. A comparison of the amounts of dust made in cutting coal by chain and by puncher machines. 1000 w. Mines & Min—May, 1908. No. 92029 C.

A Spraying Device for Laying Dust in Coal Mining. William Clifford. Illustrated description of apparatus for removing dust and conveying it from the mine. 1200 w. Mines & Min—May, 1908. No. 92032 C.

See also Ventilation, under COAL AND COKE.

Mining.

Mining Coal with the Panel System. Audley-H. Stow. Discusses the operation with reference to concentration and economy. Ills. 3800 w. Eng & Min Jour—May 2, 1908. No. 92076.

Some Experiments and Improvements in Mining in Austria. (Einige Versuche und Verbesserungen beim Bergbau in Oesterreich). Discusses present practice in coal mining, outlining methods of blasting, timbering, lighting, etc. Ills. 2000 w. Serial. 1st part. Oest Zeitschr f Berg- u Hüttenwesen—April 4, 1908. No. 92444 D.

Montana.

The Coal Industry of Montana. Jesse P. Rowe. Information concerning the extent of the deposits, their value, development, etc. Ills. 3300 w. Eng & Min Jour—May 23, 1908. No. 92532.

Ohio.

Desiccation Conglomerates in the Coal-Measures Limestone of Ohio. Jesse E. Hyde. Considers a type of intra-formational conglomerate, giving a possible explanation of the origin. 3500 w. Am Jour of Sci—May, 1908. No. 92022 D.

Production.

Past and Future Coal Production in the United States. E. W. Parker. Estimates of the amount of coal deposits, with statistics of past production and probabilities for the future. 4000 w. Mines & Min—May, 1908. No. 92027 C.

Rescue Appliances.

Rescue Apparatus in Coal Mines. Walter E. Mingramm. Illustrated description of the Draeger apparatus. 1200 w. Eng & Min Jour—May 2, 1908. No. 92077.

Ventilation.

Need of Thorough Ventilation in Coal Mines. J. R. Robinson. Shows that lack of ventilation and presence of dust are the chief causes of explosions. 1800 w. Eng & Min Jour—May 9, 1908. No. 92201.

See also same title, under MINING.

COPPER.

Blast Furnaces.

See Refineries, under COPPER.

Casting Machines.

A Machine for Casting Converter Copper. J. H. Klepinger. Illustrates and describes a machine in use at Great Falls, Montana. 1000 w. Eng & Min Jour—May 2, 1908. No. 92078.

Lake Superior.

See Copper, under ORE DRESSING AND CONCENTRATION.

Reduction.

The Reduction of Copper from Its Ores by Mechanical Energy (Ueber Kupfergewinnung aus Erzen wesentlich durch mechanische Energie). Dr. O. Frölich. Describes a new method of agitation and leaching with ferric chloride and precipitation of copper on iron. Ills. 2000 w. Elektrotech Zeitschr—April 23, 1908. No. 92492 D.

Refineries.

The Tank House and Copper Furnaces of the New Addition to the Raritan Copper Works. Frank D. Easterbrooks. Illustrated detailed description. 2000 w. Elec-Chem and Met Ind—June, 1908. No. 92621 C.

Smelters.

The Great Cobar Smelting Works. Illustrates and describes a copper-smelting plant in Australia, showing latest practice. 3000 w. Eng & Min Jour—May 9, 1908. No. 92199.

Utah.

The Boston Consolidated Mining Company. Abstract of report of progress presented Jan. 20, 1908. 5000 w. Mines & Min—May, 1908. No. 92024 C.

See also Copper, under ORE DRESSING AND CONCENTRATION.

GOLD AND SILVER.

Alloys.

See same title, under MISCELLANY.

Assaying.

United States Assay Office at Helena, Montana. Evans W. Buskett. Illus-

trated description of the building, equipment, and methods. 1200 w. Min Wld—May 16, 1908. No. 92335.

Australia.

Golden City of the Commonwealth of Australia. John Plummer. Information concerning Bendigo. Ills. 1000 w. Min Wld—May 23, 1908. No. 92572.

Cobalt.

Report on Cobalt District for Year 1907. Arthur A. Cole. Extracts from the report, with comments. 2500 w. Can Min Jour—May 1, 1908. No. 92143.

Coniagas Mine and Its Management, Cobalt. Alex. Gray. An illustrated description of this property and its equipment. 2000 w. Min Wld—May 9, 1908. No. 92214.

Metallurgical Conditions at Cobalt, Ontario, Canada, 1908. F. N. Flynn. A general description of conditions with the aim of interesting those who have successfully treated this class of ores. 14000 w. Qr Bul Can Min Inst—May, 1908. No. 92611 N.

Colorado.

Cripple Creek Rejuvenated. R. L. Herrick. Outlines present conditions and problems in this district. 3500 w. Mines & Min—May, 1908. No. 92030 C.

Cyaniding.

See Gold Milling, and Slimes Treatment, under ORE DRESSING AND CONCENTRATION.

Dredging.

Recent Developments in Gold Dredging, particularly in the Guianas (Les récents Développements des Dragages aurifères dans le Monde et particulièrement dans les Guyanes). L. Delvaux. An elaborate paper discussing gold dredging problems of all kinds and reviewing the present state of the industry. Ills. 18400 w. Mem Soc Ing Civ de France—Feb., 1908. No. 92403 G.

Montana.

Discovery of Large Gold Nuggets in Montana. Matt. W. Alderson. An account of large nuggets found and the difficulty in locating their origin. 1500 w. Min Wld—May 2, 1908. No. 92086.

Nevada.

Goldfield, Nevada. T. A. Rickard. The history of its discovery and development. Ills. 2500 w. Min & Sci Pr—April 25, 1908. Serial. 1st part. No. 92044.

Placers.

Geology and Economics of Rio San Juan, Utah. Arthur Lakes. The peculiar structure is described, and a theory of the origin of the placer gold is given. 1000 w. Min Wld—May 9, 1908. No. 92217.

Rand.

Notes on Rand Mining. Tom Johnson. A critical review of the mining practice and changes that would tend to economy. 9000 w. Jour Chem, Met & Min Soc of S Africa—March, 1908. No. 92345 E.

River Beds.

Improved Apparatus for Mining in River Beds. J. W. Hunsaker, V. Beisswingert, and R. L. Davis. Illustrates and describes an invention for reaching pockets of gold-bearing sands or gravels. 2000 w. Min Wld—May 23, 1908. No. 92571.

Utah.

See Placers, under GOLD AND SILVER.

IRON AND STEEL.

Armor Plate.

See Armor, under MARINE AND NAVAL ENGINEERING.

Assaying.

The Determination of Sulphur in Pig Iron and Steel by the Hydrogen Jet Method. Randolph Bolling. Gives a method applicable to brands that do not give satisfactory results with the "evolution method." Ills. 2000 w. Eng News—May 7, 1908. No. 92180.

The Influence of the Presence of Other Metals on the Reinhardt Method of Titration for Iron (Ueber den Einfluss der das Eisen begleitenden fremden Metalle auf die Eisentitration nach C. Reinhardt). The results of researches to determine the influence of copper, arsenic, chromium, nickel, cobalt, titanium, lead and antimony on the accuracy of the permangamate method. 3500 w. Stahl u Eisen—April 8, 1908. No. 92437 D.

Bessemer Process.

The Flohr Improvement of the Basic Bessemer Process. Abstract translation from the article by Dr. P. Goerens, in *Stahl und Eisen*. A review of the conditions affecting this process. 1600 w. Ir Age—May 28, 1908. No. 92653.

Blast Furnace Practice.

Blast Furnace Calculations. S. J. Koshkin. Gives calculations for everyday practice, suggesting new ideas. 4500 w. Ir Age—May 28, 1908. No. 92652.

Practical Blast-Furnace Management. Randolph Bolling. Shows how mechanical improvements have relieved managers, and discusses the needs of the metallurgical department. Ills. 2000 w. Eng & Min Jour—May 16, 1908. No. 92299.

Blowing Engines.

A 2000 H. P. Gas Engine Blowing Unit. Illustrated description of an example of recent gas engine and blowing engine development as installed in a Pittsburg plant. 3500 w. Mach, N Y—May, 1908. No. 92092 C.

Canada.

The Iron Ores of Canada. C. K. Leith. Gives a comparison of Canadian ores with types in the United States and dis-

cusses their commercial importance. 5500 w. Qr Bul of Can Min Inst—May, 1908. No. 92604 N.

China.

The Iron Industry of China. A short description of the Hanyang Iron & Steel Works, from an article by C. Blauel in *Stahl und Eisen*. 2500 w. Ir Age—May 7, 1908. No. 92162.

Duplex Process.

See Steel Works, under IRON AND STEEL.

Electro-Metallurgy.

The Reduction of Iron Ores in the Electric Furnace. R. Turnbull. Outlines the progress since March, 1906. 2500 w. Qr Bul of Can Min Inst—May, 1908. No. 92608 N.

Commercial Electric Steel and Gas Power. R. H. Wolff. An editorial letter giving an account of what is being accomplished with the Héroult electric process, with tables from the works laboratory at La Praz, France. 1200 w. Elec-Chem & Met Ind—June, 1908. No. 92618 C.

Electric Induction Furnaces (Elektrische Induktions-Oefen). The first part of the serial reviews the history of this type of furnace. Ills. 1500 w. Serial. 1st part. Elektrochem Zeitschr—April, 1908. No. 92434 D.

India.

Do Conditions in India Justify a National Steel Industry? Axel Sahlin. Abstract of a lecture delivered in India. A discussion of the resources and conditions, with favorable conclusions. 5800 w. Ir & Coal Trds Rev—April 24, 1908. No. 92132 A.

New Brunswick.

A New Iron Ore Field in the Province of New Brunswick. John E. Hardman. An Account of deposits of merchantable iron ore near the Bay of Chaleur. 3000 w. Qr Bul of Can Min Inst—May, 1908. No. 92606 N.

Norway.

South Varanger Iron Ore Deposits. Information concerning these large deposits, taken from a lecture by Mr. Wiull, to the Chem. Soc., at Christiania. 1600 w. Ir & Coal Trds Rev—May 8, 1908. No. 92363 A.

Ontario.

The Iron and Steel Industry of the Province of Ontario, Canada. Jas. Grannis Parmelee. Gives an outline of the more important plants. Ills. 7000 w. Qr Bul of Can Min Inst—May, 1908. No. 92605 N.

Open Hearth.

Important Points in the Construction and Operation of Gas Producers in Open Hearth Plants (Wichtige Gesichtspunkte für den Bau und Betrieb von Gaserzeuger-Anlagen bei Martinwerken). C. Canaris. Emphasizes particularly the importance of using perfectly dry gas for firing open-hearth furnaces. 4000 w. Stahl u Eisen—April 15, 1908. No. 92438 D.

Rails.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Rolling Mills.

Improvements in Plate Rolling Mills. Andrew Lamberton. Read before the Iron & Steel Inst. Illustrated description of a new form of plate mill designed by the writer, specially for light plates, but suitable for ordinary ship and girder-plates. 3200 w. Engng—May 15, 1908. No. 92564 A.

Power Requirements of Steam and Electrically Driven Rolls (Kraftbedarf von Umkehrwalzwerken mit Dampf- und elektrischem Antrieb). H. Ortmann. A comparison of power consumption and costs. Ills. 2100 w. Stahl u Eisen—April 22, 1908. No. 92440 D.

Electrically Driven Reversing Mill at the Georgs-Marien Works (Elektrisch betriebenes Umkehr- Blockwalzwerk der Georgsmarienhütte). Karl Wendt. An illustrated detailed description of the equipment and operation of this plant, with data on power consumption, etc. 5200 w. Stahl u Eisen—April 22, 1908. No. 92442 D.

See also Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Steel Making.

Calcium Silicide for the Purification of Metals, Particularly Steel. Hans Goldschmidt. An account of this new and effective purifying agent which is used exactly like aluminum. 600 w. Elec-Chem & Met Ind—June, 1908. No. 92620 C.

See also Bessemer Process, under IRON AND STEEL.

Steel Works.

The Duplex Steel Process at Ensley, Alabama. Illustrated description of the new Bessemer and open-hearth plant of the Tennessee Coal, Iron & Railroad Co., and the connected blast furnaces of modern type. 8500 w. Ir Age—May 21, 1908. No. 92502.

LEAD AND ZINC.

Pigments.

From Mine to Battleship. T. A. Rickard. An illustrated account of the manufacture of white lead paint. 11500 w. Min & Sci Pr—May 9, 1908. No. 92278.

Missouri.

Calamine Deposits of Southwest Missouri. Otto Ruhl. Describes the deposits and methods of mining. 2200 w. Min Wld—May 16, 1908. No. 92334.

We supply copies of these articles. See page 658.

See also Royalties, under MINING; and Zinc Milling, under ORE DRESSING AND CONCENTRATION.

MINOR MINERALS.

Cement.

Mill B of the Pacific Portland Cement Company, Con., near Suisun, Cal. F. D. Wood. Illustrates and describes a fireproof plant, and its equipment. 3000 w. Eng Rec—May 23, 1908. No. 92537.

Cobalt.

See same title, under GOLD AND SILVER.

Graphite.

Modes of Occurrence of Canadian Graphite. H. P. H. Brumell. Considers deposits in the Archaean rocks in the counties of Labelle and Argenteuil, Quebec. Discussion. 5500 w. Qr Bul of Can Min Inst—May, 1908. No. 92609 N.

Manganese.

Manganese Mining in Bukowina (Manganerz-Bergbau in der Bukowina). Theodor Naske. Describes the ore-dressing methods in this Austrian district. Ills. 2500 w. Stahl u Eisen—April 15, 1908. No. 92439 D.

Oil.

Prospecting in the Oil Fields of Western Colorado. Arthur Lakes. Describes five oil-bearing zones west of the Continental Divide. Map. 2000 w. Min Sci—April 30, 1908. No. 92081.

Rare Metals.

The Rare Metals, Cobalt, Vanadium, Molybdenum, Titanium, Uranium and Tungsten, and their Uses, especially in the Steel Industry (Die seltenen Metalle, Kobalt, Vanadium, Molybdän, Titan, Uran, Wolfram und ihre Bedeutung für die Technik unter besonderer Berücksichtigung der Stahlindustrie). A. Haenig. Gives considerable information of the ores, sources, uses, etc., of the metals named. 2300 w. Serial. 1st part. Oest Zeitschr f Berg- u Hüttenwesen—April 11, 1908. No. 92445 D.

Tungsten.

The Occurrence of Tungsten Ores in Canada. T. L. Walker. Information regarding recently recorded discoveries, describing some occurrences. 1200 w. Qr Bul of Can Min Inst—May, 1908. No. 92610 N.

MINING.

Drills.

Development of the Air-Hammer Rock Drill. Claude T. Rice. Describes new features of the Kimber and the Flottmann machines. Ills. 800 w. Eng & Min Jour—May 23, 1908. No. 92528.

Electric Hoisting.

The Application of the Extended Cascade Connection in Hoisting and Similar Plants and in the Operation of Electric Railways (Die Verwendung der erweiterten Kaskadenschaltungen in Förderanlagen und ähnlichen Betrieben und in elektrischen Bahnbetriebe). A. Heyland. Illustrates and describes the proposed arrangement. 2000 w. Serial. 1st part. Elektrotech Zeitschr—April 2, 1908. No. 92485 D.

See also Hoisting, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Electric Power.

Electricity in Mines: Breakdowns of Machinery, and the Causes of Accidents. A criticism of English practice. 2000 w. Elec Rev, Lond—May 15, 1908. No. 92555 A.

The Choice of Electric Motors for Mine Equipment. A. W. K. Peirce. Deals with three-phase motors of the induction type. 5000 w. Jour S African Assn of Engrs—March, 1908. No. 92101 F.

See also same title, under COAL AND COKE.

Engineering Ethics.

Advice to Mining Students. J. H. Collins. The Le Neve Foster lecture to the students of the Royal School of Mines. A survey of the work of the mining engineer. 3800 w. Min & Sci Pr—May 9, 1908. No. 92279.

Fans.

The Barclay "Drum Pattern" Mine Fan. Illustrated description of a new type of fan for ventilating mines. 1600 w. Col Guard—April 24, 1908. No. 92119 A.

Finance.

Stock Companies and Company Promotion. Henry A. Butters. A synopsis of two lectures delivered to the Seniors of the School of Mines, University of California. 5500 w. Min & Sci Pr—May 2, 1908. No. 92164.

Freezing Process.

Application of Refrigeration to Mining Work. Jos. H. Hart. Describes its use in the sinking of shafts and building of tunnels, etc., and the various processes. 2000 w. Min Wld—May 9, 1908. No. 92216.

Hoisting.

Over-Balance Weight for Single-Drum Hoist. S. A. Worcester. Explains the principles of the arrangement and the advantages. Ills. 1400 w. Eng & Min Jour—May 2, 1908. No. 92079.

Law.

The Rights of the Miner. Theo. F. Van Wagenen. Discusses existing laws as related to prospectors, laboring miners, mining engineers, and mining investors. 5000 w. Min & Sci Pr—May 16, 1908. No. 92511.

Short Talks on Mining Law. A. H.

Ricketts. The first of a series of articles discussing this subject. 2000 w. Eng & Min Jour—May 9, 1908. Serial. 1st part. No. 92198.

Ore Contracts.

Ore Contracts from a Producer's Point of View. Henry M. Adkinson. Discusses ore contracts, treatment charges, competition, and gives examples and results. 1500 w. Eng & Min Jour—May 16, 1908. No. 92300.

Problems.

On Some Unsolved Problems in Metal Mining. Prof. Henry Louis. The James Forrest lecture, before the Inst. of Civ. Engrs., April 27, 1908. Considers problems of mining and extraction of metals from their ores. 4500 w. Engng—May 1, 1908. Serial. 1st part. No. 92249 A.

Royalties.

Sliding Scale Royalty. Louis D. Huntoon. Read before the Engrs' Soc. of S.-W. Missouri. Explains a proposed system of royalties to obviate the disadvantages of the present system in the Missouri zinc region. 1200 w. Mines & Min—May, 1908. No. 92033 C.

Shaft Sinking.

Sinking a Concrete-Lined Mine Shaft. Illustrated description of work at the Woodward colliery, near Wilkes-Barre, Penn. 1200 w. Eng Rec—May 16, 1908. No. 92312.

Collar at No. 1 Allan Shaft. H. E. Coll. Read before the Min. Soc. of Nova Scotia. Describes methods of sinking through water-bearing sand. 1700 w. Can Min Jour—May 15, 1908. No. 92328.

See also Freezing Process, under MINING.

Stoping.

Stoping Without Timbers at the Homestake Mine, Lead, South Dakota. Mark Ehle, Jr. Illustrated description of a method adapted to working large ore bodies. 1800 w. Mines & Min—May, 1908. No. 92026 C.

Timbering.

Timbering Methods in Missouri-Kansas District. Otto Ruhl. Methods of lacing and "swinging crib" to strengthen shaft timbering are described. Ills. 3000 w. Min Wld—May 2, 1908. No. 92084.

Developments in Mine Timbering (Neuerungen im Grubenausbau). Dr. Hecker. Refers to the use of iron and concrete in place of wood. Ills. 4200 w. Glückauf—April 18, 1908. No. 92447 D.

Wood and Iron as Mine Timbering Materials (Holz und Eisen als Ausbaumaterial in Strecken- und Abbaubetrieben). Heinrich Steffen. A discussion of their respective merits. Ills. 2100 w. Serial. 1st part. Stahl u Eisen—April 1, 1908. No. 92436 D.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Valuation.

Mine Valuations. Algernon Del Mar. Explains the basis of calculation. 1400 w. Eng & Min Jour—May 23, 1908. No. 92530.

Structural Maps and Their Use in Making Up Reports. J. E. Tiffany. The advantages of topographical information in the calculating of estimates of costs of development and construction. 1600 w. Min Sci—May 7, 1908. No. 92213.

Ventilation.

The Economy of Modern Colliery Ventilation. J. R. Robinson. Claims that high-speed centrifugal fans afford seven times the efficiency of screw-type ventilators and effect an annual saving of $5000. 5400 w. Eng & Min Jour—May 16, 1908. No. 92302.

ORE DRESSING AND CONCENTRATION.

Briquetting.

See Magnetic Separation, under ORE DRESSING AND CONCENTRATION.

Copper.

The Calumet & Hecla Stamp Mills, Lake Superior. Robert H. Maurer. Illustrated description of mill and equipment for treating copper ore. 3000 w. Min Wld—May 2, 1908. No. 92083.

Three-Thousand-Ton Concentrator of the Boston Consolidated Mining Company, at Garfield, Utah. Robert B. Brinsmade and R. L. Herrick. Illustrates and describes the arrangement of machinery and the methods, giving estimates of cost. 3500 w. Mines & Min—May, 1908. No. 92023 C.

Gold Milling.

Goldfield Consolidated Mining Company's New Mill. Describing the location, construction, equipment, flow sheet and methods. 1200 w. Min Sci—May 7, 1908. No. 92212.

Montana-Tonopah Stamp and Cyanide Mill. Illustrated description of plant where the crushed ore is concentrated on Wilfley tables and vanners and the slimes are treated in Hendryx cyanide agitators. 1200 w. Eng & Min Jour—May 9, 1908. No. 92200.

See also Conveyors, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Magnetic Separation.

Progress with the Gröndal Process of Concentrating and Briquetting Iron Ores. P. McN. Bennie. Shows how the mining of certain kinds of iron ores has been stimulated by the demands of metallurgy, and the progress of this process. Discussion. 3000 w. Qr Bul of Can Min Inst—May, 1908. No. 92607 N.

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Mixed Sulphides.

Concentrating Mixed Ores at Rosas, Sardinia. Umberto Cappa. Describes the separation of lead and zinc from mixed oxidized and sulphide ores by crushing in ball mills and washing over Ferraris tables. 1200 w. Eng & Min Jour—May 9, 1908. No. 92197.

Slimes Treatment.

The Separation of Slime in Cyanide Treatment. Horace G. Nichols. Describes the process and gives a report of experimental tests and information related. 2500 w. Min & Sci Pr—April 25, 1908. No. 92045.

Zinc Milling.

Milling Methods in the Kansas-Missouri Zinc Fields. Doss Brittain. Description of methods and development. Ills. 1200 w. Min Sci—April 30, 1908. No. 92082.

The American Mill at Oronogo, Joplin District. Doss Brittain. Illustrates and describes a typical plant for concentrating sheet-ground ore, but differing in some essential details from practice prevailing at Joplin. 1600 w. Eng & Min Jour—May 23, 1908. No. 92529.

MISCELLANY.

Alloys.

The Alloys of Gold (Les Alliages d'Or). M. A. Portevin. Discusses the metallographic properties of alloys of gold with bismuth, cadmium, copper, iron, nickel, palladium, platinum, lead, antimony, tin, thalium and zinc, after articles in the *Zeitschr. an. Chemie.* Ills. 4000 w. Rev de Métal—April, 1908. No. 92496 E + F.

Brazil.

The Mining Industry in the State of Minas Geraes, Brazil. G. Campbell. Discusses mining laws, labor, wages, etc. 1800 w. Min Jour—April 25, 1908. Serial. 1st part. No. 92118 A.

British Columbia.

Mineral Locations on Moresby Island—One of the Queen Charlotte Islands. Abstract of Bul. No. 1, issued by B. C. Bureau of Mines. Historical and descriptive. Map. 3500 w. Can Min Jour—May 15, 1908. Serial. 1st part. No. 92327.

Colorado.

The Various Mining Districts of Colorado. G. W. Miller. First article of a series describing the mining camps, their history, geology, ores, methods of mining and ore treatment. Maps. 1400 w. Min Sci—May 14, 1908. Serial. 1st part. No. 92336.

Fireclay Crucibles.

Zinc Retorts and Refractory Crucibles: A New Method of Construction. Illustrates and describes a process for the manufacture of composite retorts for the metallurgy of zinc and composite crucibles. 2200 w. Ir & Coal Trds Rev—May 1, 1907. No. 92252 A.

New Guinea.

Papua Mining. J. H. P. Murray. An account of this richly mineralized region and the difficulties that confront prospectors. 6000 w. Aust Min Stand—April 1, and 8, 1908. Serial. 2 parts. No. 92254 each B.

Ore Deposits.

Formation of Mineral Veins. Dr. Willis Eugene Everette. Analysis of rocks and the metals extracted from them. 2800 w. Sci Am Sup—May 2, 1908. Serial. 1st part. No. 92020.

The Genesis of Ores in the Light of Modern Theory. Horace V. Winchell. Considers the influences and conditions that have an important bearing on the question of ore formation. 4000 w. Pop Sci M—June, 1908. No. 92616 C.

Tendencies in the Study of Ore Deposits. Waldemar Lindgren. Abstract of a presidential address before the Geol. Soc. of Washington. The prevailing theoretical tendencies are outlined. 4000 w. Min & Sci Pr—April 25, 1908. No. 92046.

Peru.

The Mining Districts of Central Peru. J. C. Pickering. An illustrated account of the silver, copper, coal and lead mines near Cerro de Pasco. 3800 w. Eng & Min Jour—May 16, 1908. No. 92301.

Refractory Materials.

Refractories Used in the Construction of Coke Ovens. J. R. Campbell. Discusses the maximum impurities permissible for satisfactory service. 3000 w. Mines & Min—May, 1908. No. 92025 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Safety in American Railway Transport. Charles A. Howard. Considers methods for reducing the number of casualties. 3500 w. Cassier's Mag—May, 1908. No. 92144 B.

The Shrewsbury Railway Accident. A review of the accident occuring Oct. 15, 1907, and of Col. Yorke's report. Also editorial. 7500 w. Engr, Lond—April 24, 1908. No. 92129 A.

Signalling.

Experiments with Railway Signal

We supply copies of these articles. See page 658.

Lights Upon Persons Having Normal and Abnormal Color Sense. Prof. W. A. Nagel. Trans. from *Zeit. für Sinnesphysiologie*. Discusses how such tests should be made. 2500 w. Ry Age—May 22, 1908. No. 92573.

MOTIVE POWER AND EQUIPMENT.

Air Pumps.

Care of Air Pump. Suggestions for care and maintenance. 2000 w. Ry & Loc Engng—May, 1908. No. 92058 C.

Cars.

Passenger Cars for the Philippine Railway. Illustrated description. 1000 w. Am Engr & R R Jour—May, 1908. No. 92097 C.

A 28-Ton Bogie Coal Wagon. Illustrated description of cars for the Federated Malay States Rys. 300 w. Engr, Lond—May 15, 1908. No. 92568 A.

High-Capacity Wagons for Indian Broad-Gauge Railways. H. Kelway-Bamber. Shows the development during the past fifteen years, discussing the earning power and carrying capacity. Ills. 1200 w. Engng—May 8, 1908. No. 92356 A.

Car Springs.

Laminated Springs for Private Owners' Wagons. Editorial on the desirability of uniformity in the testing and working of laminated springs. Ills. 1400 w. Engng—April 24, 1908. No. 92123 A.

Draft-Gears.

Draft-Gear Proposition. R. P. C. Sanderson. Discusses the shocks and strains that modern cars must sustain, and the efficiency of the draft gear. General discussion. 19000 w. N Y R R Club—April 17, 1908. No. 92290.

Electrification.

The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City. Continued discussion, with diagrams. 10800 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92647 E.

From Steam to Electricity on a Single Track Road. J. B. Whitehead. Describes the Annapolis Short Line, giving reasons for the change, and discussing and comparing results, costs, etc. 10000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92386 D.

Locomotive Boilers.

Locomotive Boilers. W. L. French. On the growth from the small to the large boiler, its construction, testing, care, etc. 2000 w. Boiler Maker—May, 1908. No. 92091.

Locomotive Fuels.

Burning Lignite Coal in Locomotives. O. N. Terry. A report of the success attained on the Burlington road in the use of this fuel. Ills. 1800 w. Am Engr & R R Jour—May, 1908. No. 92096 C.

Locomotives.

Remarkable Locomotives of 1907. J. F. Gairns. A review of progress in Europe and America, illustrating 27 locomotives. 8500 w. Cassier's Mag—May, 1908. No. 92145 B.

Ten-Wheel Passenger Locomotives for the 'Frisco. Illustrated detailed description. 700 w. R R Gaz—May 8, 1908. No. 92175.

Ten-Wheel Passenger Locomotive—St. Louis and San Francisco Railroad. Illustrated description. 600 w. Am Engr & R R Jour—May, 1908. No. 92098 C.

Pacific Locomotive for the New York Central. Illustrated description of the heaviest passenger engines ever built for this road. 900 w. Ry Age—May 1, 1908. No. 92087.

Prairie Locomotive for the Wabash. Illustrated description of engines of this type, of which 30 have recently been built. 400 w. Ry Age—May 8, 1908. No. 92225.

Central of Georgia 2-8-0. Illustrated description of a consolidation engine equipped with a feed water heater. 600 w. Ry & Loc Engng—May, 1908. No. 92057 C.

Pacific and Consolidation Locomotives for the Santa Fé. Illustrates and describes these types of recently built engines; seven for passenger, and 42 for freight service. Ten are for coal burning and the remainder for oil burning. 800 w. Ry Age—May 15, 1908. No. 92331.

Great Central Compound Engines and Their Work. Charles Rous-Marten. Gives particulars of work performed by these engines. 2200 w. Engr, Lond—April 24, 1908. No. 92127 A.

Consolidation Type Locomotive—Great Northern Railway. Illustrates and describes the somewhat unusual arrangement of the Walschaert valve gear. 500 w. Am Engr & R R Jour—May, 1908. No. 92099 C.

Double-Ended Goods Type Locomotive. Illustrated description of a new type recently constructed for the express passenger trains of the State Rys. of Italy. 1400 w. Engr, Lond—May 8, 1908. No. 92362 A.

German Locomotives with Schmidt Superheaters and Record of Trials. Illustrates and describes two of the latest designs for passenger and freight service, with an account of trials. 1500 w. Prac Engr—April 24, 1908. Serial. 1st part. No. 92106 A.

The Four-Cylinder 3/6-Coupled Compound Locomotive for High-Speed Service on the Baden State Railways (Die vierzylindrige 3/6-gekuppelte Verbund-Schnellzuglokomotive der Badischen Staatsbahnen). Herr Courtin. Illustrated

We supply copies of these articles. See page 658.

description. Plate. 1500 w. Zeitschr d Ver Deutscher Ing—April 11, 1908. No. 92478 D.

See Shop Practice, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES; and Elevated Railways, under STREET AND ELECTRIC RAILWAYS.

Locomotive Superheaters.

The Origin of Superheaters, Consisting of U-Shaped Pipes Placed in the Boiler Tubes. Charles R. King. Reviews past history and considers de Monteheuil the original inventor of this type. Ills. 2200 w. Bul Int Ry Cong—April, 1908. No. 92322 G.

Wheels.

For Better Car Wheels. P. H. Griffin. On the danger of cast-iron wheels, as now made, under 50-ton cars, and the need of an agreement about car-wheels between all roads exchanging cars. 2200 w. R R Gaz—May 22, 1908. No. 92520.

PERMANENT WAY AND BUILDINGS.

Construction.

Railroad Grading by Hydraulic Methods on the Chicago, Milwaukee & St. Paul Railway. Illustrated description of work in the State of Washington. 4500 w. Eng Rec—May 2, 1908. No. 92066.

Curves.

A New Method of Joining Curves (Nouvelle Méthode de Raccordement des Courbes). E. Hallade. A mathematical paper. Ills. 9000 w. Rev Gen d Chemins de Fer—April, 1908. No. 92411 G.

Earth Slides.

The Improvement of a Sliding Cut on the Cleveland, Cincinnati, Chicago & St. Louis Ry. Information concerning measures adopted to remedy a wet and sliding sidehill cut. Ills. 1200 w. Eng News—April 30, 1908. No. 92013.

Location.

Mountain Railroad Location. J. J. Cryderman. Paper presented to the Pacific N.-W. Soc. of Engrs. Suggestions for the selection of the personnel of the party, the instruments, and other equipment, methods of work, etc. 6000 w. R R Gaz—May 15, 1908. No. 92285.

Rails.

Steel-Rail Breakages. Questions of Design and Specifications. Harold V. Coes. A comparison of views of maker and consumer as to the causes. 2500 w. Engineering Magazine—June, 1908. No. 92630 B.

Specifications for Bessemer and Open Hearth Rails. Gives specifications adopted by the American Ry. Assn., with remarks. 3000 w. Ir Trd Rev—April 30, 1908. No. 92039.

New Rail Sections and Rail Specifications of the American Railway Association. Extracts from the Committee reports, giving specifications, with comments, and editorial. 5500 w. Eng News—May 14, 1908. No. 92277.

Heat Treatment of Steel Rails. William Metcalf. On the principles and processes involved in the handling of steel, and the applications of those principles. Discussion. 8000 w. Pro Engrs' Soc of W Penn—April, 1908. No. 92256 D.

The Prevention of Play Between Rail and Fishplate. Leon Edelstein. Trans. from *Zeit. des Oest Ing. u Archt. Ver.* Describes a new method of overcoming the evils due to wear of rails and fishplates by use of steel packing prices. Ills. 1700 w. Bul Int Ry Cong—April, 1908. No. 92324 G.

Stations.

Ottawa Union Passenger Station. Illustrated description of a fine station. 900 w. R R Gaz—May 1, 1908. No. 92048.

Terminals.

Erie Terminal Improvements in Jersey City. An illustrated description of the proposed track arrangement, and the general plan of the Bergen Hill cut. 2000 w. R R Gaz—May 15, 1908. No. 92286.

Ties.

Metal and Reinforced Concrete Ties. Editorial discussion of various types. 4000 w. R R Gaz—May 1, 1908. No. 92047.

Experiments with Railway Cross-Ties. A report of an investigation of the timber accessible to the Northern Pacific Railroad, to determine the most economical system of handling and manufacturing into cross-ties. 2000 w. Eng Rec—May 16, 1908. No. 92313.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Water Supply.

See Water Works, under CIVIL ENGINEERING, WATER SUPPLY.

Yards.

Some Notes on North American Goods Yards. Dr. Blum and E. Giese. Trans. from *Zeit. des Ver Deutscher Ing.* Describes American practice, giving plans. 6000 w. Bul Int Ry Cong—April, 1908. No. 92323 G.

TRAFFIC.

Car Efficiency.

Freight Car Efficiency. E. R. Dewsnup. A discussion of American freight operation, the adequacy of car equipment, and related matters. General discussion. 12000 w. Pro W Ry Club—April 21, 1908. No. 92575 C.

Car Interchange.

Report of the Committee of the Railway Club of Pittsburgh on the Revision of M. C. B. Rules of Interchange. Gives

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the changes recommended. 7000 w. Pro Ry Club of Pittsburgh—March 27, 1908. No. 91995 C.

Freight Rates.

Freight Rate Complaints Under the Hepburn Law. Logan G. M'Pherson. A classified review of the complaints entered. 4000 w. Ry Age—May 8, 1908. No. 92226.

MISCELLANY.

Accounting.

Railroad Accounting Under Government Supervision. M. P. Blauvelt. Abstracts of an address before the Assn. of Am. Ry. Acc. Officers. The question of depreciation is discussed. 2200 w. Ry Age—May 15, 1908. No. 92333.

Africa.

The Railways of French West Africa (Les Voies Ferrées de l'Afrique Occidentale Française). The first part discusses the general programme. Ills. 9000 w. Serial. 1st part. Rev Gen des Sci—March 30, 1908. No. 91520 D.

Alaska.

Railway Experiences in Alaska. John H. Brooks, Jr. An interesting account of conditions met in constructing the Alaska Central Railway. 4000 w. Jour Worcester Poly Inst—May, 1908. No. 92576 C.

Canada.

See same title, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

China.

Existing and Projected Railroads in China. Brief report of these lines and related information. 2500 w. R R Gaz—May 8, 1908. No. 92171.

The Shanghai-Nanking Railroad. An illustrated description of the construction of this and connecting lines. 800 w. R R Gaz—May 15, 1908. No. 92288.

France.

French Railroads in 1905 and 1906. C. Colson. A review of results and of conditions affecting the railroad industry, comparing with England and Germany. 5000 w. R R Gaz—April 24, 1908. No. 91905.

Government Control.

Work of Interstate Commerce Commission Under the Hepburn Act. E. A. Moseley. On the great increase of work and the methods of conducting it. 3500 w. Ry Age—May 15, 1908. No. 92330.

How Can the Railroads Best Serve the Public? Stuyvesant Fish. Recommendations are given. 700 w. R R Gaz—May 22, 1908. No. 92523.

Railroad Regulation. Robert Mather. From an address before the Traffic Club of Pittsburg. A discussion of the government control of railways and the effects. 3000 w. R R Gaz—May 15, 1908. No. 92287.

Practical versus Theoretical Railway Regulation. Martin S. Decker. Abstract of an address before the Traffic Club of New York. 2000 w. Ry Age—May 1, 1908. No. 92088.

Working of the Massachusetts Stock Law. From the majority report of the Commission on Commerce and Industry. Discusses some of the provisions for increasing the capital of public service corporations. 4500 w. R R Gaz—May 8, 1908. No. 92174.

See also Accounting, under MISCELLANY.

Guatemala.

The Guatemala Railroad. An illustrated account of this new line connecting the city of Guatemala with the Atlantic. 1000 w. R R Gaz—April 3, 1908. No. 91436.

India.

Indian Railway Facilities (Das Verkehrswesen Vorderindiens). Dr. Blum. Discusses traffic requirements, railway facilities, equipment, etc. Ills. 5000 w. Glasers Ann—Mar. 1, 1908. No. 91576 D.

Italy.

Railway Reorganization in Italy. Editorial discussion in *Bulletin des transports internationaux par chemins de fer.* 16300 w. Bul Int Ry Cong—April, 1908. No. 92326 G.

Management.

Personalism in Railroading. H. W. Jacobs. Discusses the individual element in railway organization. A study of changing conditions. 3500 w. Engineering Magazine—June, 1908. No. 92628 B.

Narrow Gauge.

The Krivaja Forest Railway in Bosnia (Ueber die Krivaja-Waldbahn in Bosnien). Herr Liebmann. A general description of this 0.76 metre gauge line and its equipment and traffic. Ills. 5500 w. Glasers Ann—April 15, 1908. No. 92459 D.

The Sokoliki-Stuposiany Timber Railway (Die Waldbahn Sokoliki-Stuposiany). An illustrated description of the line and equipment of this 0.76 metre gauge railway in Galicia. 2500 w. Mit d Ver f d Förd Lokal u Strassenbahnwesens—March, 1908. No. 92432 F.

Queensland.

The Queensland Railways and Maintenance Costs. Editorial review of the lately-issued report of the working of the State railways. 2000 w. Engng—March 20, 1908. No. 91278 A.

Southern Pacific.

The Sunset Route. Illustrated account of the line and its equipment. 1000 w. Ry & Loc Engng—May, 1908. No. 92056 C.

Turkey.

The Anatolia Railway (Die Anatolische Bahn). Herr Denicke. An illustrated general description. 4500 w. Glasers Ann—April 1, 1908. No. 92458 D.

We supply copies of these articles. See page 658.

STREET AND ELECTRIC RAILWAYS

Austria.

The Selection and Application of Alpine Water Powers as Sources of Power for Electric Operation of Trunk Lines (Die Auswahl und der Ausbau alpiner Wasserkräft zum Zweck des elektrischen Vollbahnbetriebes). Dr. W. Conrad. A discussion of the technical and economic aspects of railway electrification in Austria. Ills. 1800 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—April 10, 1908. No. 92456 D.

Baltimore.

Generating and Distributing Systems of the United Railways and Electric Company of Baltimore. Illustrated detailed description of the work of reconstruction and extension in progress. 2500 w. Elec Wld—May 9, 1908. No. 92176.

The Reconstruction of the Power System of the United Railways & Electric Company of Baltimore. Explains the circumstances that made the reconstruction necessary, illustrating and describing the extensions and improvements, etc. 4000 w. St Ry Jour—May 9, 1908. No. 92165.

Brakes.

Pringle's Groove Skid Emergency Brake. Illustrated detailed description. 2500 w. Elect'n, Lond—May 1, 1908. No. 92244 A.

Pringle's Emergency Brake. Illustrated description, with statement of advantages claimed, and report of tests. 1500 w. Elec Rev, Lond—April 24, 1908. No. 92112 A.

Car Maintenance.

Graphics as Applied to Car Maintenance. William Arthur. Describes a system evolved to meet the requirements of frequent service of heavy passenger trains at high speed. 1800 w. Elec Ry Jour—June 6, 1908. No. 92733.

Conductor Testing.

Conductor Rail Measurements. S. B. Fortenbaugh. Ills. Explains methods used on the Underground Electric Railways of London. 2000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92384 D.

Controllers.

See Train Control, under STREET AND ELECTRIC RAILWAYS.

Electrification.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Elevated Railways.

The Northwestern Elevated Extension at Evanston, Ill. An illustrated account of the line and equipment. 5000 w. St Ry Jour—May 23, 1908. No. 92514.

Elevated Railways of New York. George H. Jackson. Reviews the early history and illustrates early locomotives. 1500 w. Ry & Loc Engng—May, 1908. No. 92060 C.

The Paris "Elevated." George B. Ford. Illustrated article showing the aesthetic possibilities of elevated construction. 2500 w. Archt Rev—Feb., 1908. No. 92253 E.

Freight Service.

Electric Express Service at Birmingham, Ala. An illustrated account of methods of conducting an extensive express service at freight rates. 1200 w. St Ry Jour—May 16, 1908. No. 92282.

Interurban.

Recent Work on the Fairmont & Clarksburg Traction Company's System. Important additions to this system in W. Va. are illustrated and described. A power plant, transmission line, substations and car house. 1700 w. St Ry Jour—May 16, 1908. No. 92280.

The Growth of the Kokomo, Marion & Western Traction Company. C. A. Tupper. An illustrated account of this system and its development. 3500 w. Elec Ry Rev—May 9, 1908. No. 92221.

The Indianapolis, Crawfordsville & Western Traction System. Illustrated description of a new line built for high-speed operation. 3500 w. St Ry Jour—May 23, 1908. No. 92515.

The Buffalo, Lockport & Rochester Railway. An illustrated description of the construction and equipment. 3500 w. Elec Ry Jour—June 6, 1908. No. 92732.

London.

Tilbury Railway Electrification. Illustrates and describes new work in London to relieve the congestion of traffic. 1800 w. Tram & Ry Wld—May 7, 1908. No. 92518 B.

Maintenance.

Maintenance Regulations Proposed by the Australian Street Railway Association. Regulations covering track, line, and rolling-stock. 1200 w. St Ry Jour—May 2, 1908. No. 92036.

Memphis, Tenn.

Electric Railway Traffic in Memphis. Map, and description of system serving a population of 150,000. 2500 w. Elec Ry Jour—June 6, 1908. No. 92734.

Operating Expenses.

Cost of Carrying Passengers to Coney Island. Gives an analysis of operating expenses on the passenger-mile basis. 2000 w. St Ry Jour—May 30, 1908. No. 92679.

We supply copies of these articles. See page 658.

Safety Guards.

A New Safety Guard and Sanding Device for Tram Cars. From *E. K. und B.* Illustrated description of a device experimentally tried in Vienna. 500 w. Elec Engr, Lond—May 8, 1908. No. 92348 A.

Sanding Devices.

See Safety Guards, under STREET AND ELECTRIC RAILWAYS.

Schedules.

The Determination of the Shortest Possible Interval Between Successive Trains on Urban and Suburban Lines. R. Pfeil. Trans. from *Elek. Kraft u. Bahnen.* Explains a short way of determining. Ills. 4700 w. Bul Int Ry Cong—April, 1908. No. 92325 G.

Shops.

New Shops of the Cleveland, Southwestern & Columbus Railway Company. Illustrated description. 1600 w. St Ry Jour—May 2, 1908. No. 92035.

Useful Armature Repair Shop Methods. Norman G. Meade. Illustrates and describes devices found useful in repair shops. 900 w. Elec Ry Rev—May 9, 1908. No. 92222.

Some Useful Shop Schemes. H. M. Ashenfelter. Brief illustrated notes on methods of facilitating repairs at the South Bend, Ind., shops. 900 w. Elec Ry Rev—May 2, 1908. No. 92080.

Single Phase.

Single Phase Equipment for the Richmond & Chesapeake Bay. Illustrated description of this single-track electric road with turn-outs. 1000 w. R R Gaz—May 8, 1908. No. 92172.

Tests of Single Phase Electric Traction on the Seebach-Wettingen Line (Traction électrique : Essais par Courant monophasé sur la Ligne de Seebach à Wettingen). Jean Landry. The first part of the serial discusses experiments with single-phase traction in Europe and America and their results. 4000 w. Serial. 1st part. Bul Tech d l Suisse Romande—April 10, 1908. No. 92415 D.

Single-Phase Electric Traction on the Seebach-Wettingen Line (Die elektrische Traktion mit Einphasenwechselstrom auf der S. B. B.-Linie Seebach-Wettingen). Hugo Studler. The first part of the serial gives a description of the generating station. Ills. 2700 w. Serial. 1st part. Schweiz Bau—April 11, 1908. No. 92450 D.

The 15000-Volt A. C. Railway from Seebach to Wettingen (Die 15000-Volt Wechselstrombahn Seebach-Wettingen). S. Herzog. Illustrated description of line, generating stations, equipment, etc., of this single-phase line. 1700 w. Serial. 1st part. Elek Kraft u Bahnen—April 14, 1908. No. 92475 D.

Substations.

The Ayoca Substation of the Lackawanna & Wyoming Valley Railroad Company. Illustrated description of the station and its equipment. 2000 w. St Ry Jour—May 16, 1908. No. 92281.

The Determination of the Economic Location of Sub-Stations in Electric Railways. Gerard B. Werner. A consideration of interurban and trunk line projects, or of relatively long roads. 3000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92383 D.

Subways.

Report on the Capacity of the New York Subway. Abstract of the fourth report of Bion J. Arnold, on the capacity of the subway, and making recommendations. 5500 w. St Ry Jour—May 30, 1908. No. 92680.

Power Consumption and Speed in the New York Subway. L. B. Stillwell. A report of speed and power tests carried out in the N. Y. subway about two and one-half years ago. 3000 w. Elec Ry Jour—June 6, 1908. No. 92731.

The Crossing of the Seine by Line No. 4 of the Metropolitan of Paris (Le Métropolitan de Paris. Traversée de la Seine par la Ligne No. 4). A. Dumas. Illustrates and describes the building and sinking into place of the five sections of this part of the Paris subway. 4000 w. Génie Civil—April 25, 1908. No. 92420 D.

Switzerland.

Electric Traction on the Rigi Railroad (La Trazione elettrica sulla Ferrovia del Righi). Illustrates and describes the line, equipment and operation of this mountain railroad in Switzerland. 2700 w. L'Ing Ferro—April 1, 1908. No. 92424 D.

See also Single Phase, under STREET AND ELECTRIC RAILWAYS.

Track Construction.

Track Construction. Mark Lowd. Read before the S.-W. Gas & Elec. Assn. Deals with T-rail construction in paved streets. 2000 w. St Ry Jour—May 23, 1908. No. 92516.

Track Maintenance.

Way Department of the Public Service Railway Company. Martin Schreiber. Illustrates and describes some of the methods in construction and maintenance work, especially tracks and buildings. 4500 w. St Ry Jour—May 2, 1908. No. 92034.

Train Control.

Multiple-Unit Train Control on the Lancashire and Yorkshire Railway. Illustrated description of the direct electromagnetic system, with solenoids carrying the main return current from the train motors to the rails. 1800 w. Tram & Ry Wld—May 7, 1908. No. 92519 B.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingeniería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.*- Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Shop Management.

Betterment Briefs. A Collection of Published Papers on Organized Industrial Efficiency. By H. W. Jacobs. Size, 9 by 6 in.; pp., 240. Ills. Price, $3.50. Topeka, Kans.; Published by the Author.

About four years ago the Santa Fe broke loose from the ranks of traditional railroading and adopted a general plan of shop betterment work that to many was radical if not of a revolutionary nature. That the plans outlined and carried into effect were practical and not visionary has been demonstrated in a manner as evident to the directors and stockholders as to the humblest mechanics.

Articles dealing with various phases of this work have appeared from time to time, setting forth some of its prominent objects. We now have before us a book treating of the subject of mechanical betterment in a comprehensive manner, which elucidate the elements and general principles not only as applied to the shops and management of the Santa Fe motive power, but as applicable to the practice of any progressive railroad. The plan adopted in the prosecution of this work and the methods described will strike home to every man having an interest in railroad problems. The detail descriptions of practical accomplishments will be of especial interest to railroad men who will, more than others, appreciate the magnitude of the undertaking and the far-sighted aims of the Santa Fe management in putting a pioneer work of this kind into effect. The Vice-President in charge of maintenance and operation, is known as a man who has an unusual appreciation of the relative importance of the problems confronting such an officer, and he does not hesitate to strike out into new paths if they enable the journey to be accomplished more effectively.

The betterment method described in this book is a striking example throughout of the working out of such a policy.

BOOKS RECEIVED.

The Wyoming Voluntary Publicity Law. Compiled by Henry C. Beeler. Size, 9 by 6 in.; pp., 11. Cheyenne, Wyo.: Office of the State Geologist.

Twelfth Annual Report on Highway Improvement, Ontario, 1908. Size, 10 by 6½ in.; pp., 110. Ills. Toronto, Ont.: Department of Public Works.

Proceedings of the American Railway Master Mechanics' Association, Vol. XL, 1907. Size, 9 by 6 in.; pp., 453. Ills. Chicago, Ill.: Published by the Association.

Annual Report of the Isthmian Canal Commission for the Year ended June 30, 1907. Size, 9 by 6 in.; pp., 239. Ills. Washington, D. C.: Government Printing Office.

Methods and Devices for Bacterial Treatment of Sewage. By William Mayo Venable. Size, 9 by 6 in.; pp., 236. Ills. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Practical Calculations for Engineers. By C. E. Larard and H. A. Golding. Size, 7½ by 5 in.; pp., 455. Ills. Price, $2. Philadelphia: J. B. Lippincott Company; London: Charles Griffin and Company.

Proceedings of the Fifteenth Annual Convention of the Traveling Engineers' Association held at Chicago, September, 1907. Size, 9 by 6 in.; pp., 340. Ills. Buffalo, N. Y.: Published by the Association.

Massen-Destillation von Wasser insbesondere zur Erzeugung von Trinkwasser und Lokomotiv-Speisewasser. By Ludwig Bothas. Size, 9 by 6 in.; pp., 53. Ills. Price, M. 2. Berlin: Julius Springer.

The Pollution of New York Harbor. By George A. Soper. Reprinted from the Journal of the Association of Engineering Societies, June, 1906. Size, 9 by 6 in.; pp., 33. Ills. New York: George A. Soper.

A Treatise on the Principles and Practice of Harbour Engineering. By Brysson Cunningham. Size, 9 by 6 in.; pp., xii, 283. Ills. Price, $5. Philadelphia: J. B. Lippincott Company; London: Charles Griffin & Company.

British Standard Specifications for Copper Alloy Bars for Use in Automatic Machines. Published by the Engineering Standards Committee. Size, 13 by 8 in.; pp., 13. Ills. Price 2/6. London: Crosby Lockwood & Son.

Experimental Work Conducted in the Chemical Laboratory of the United States Fuel Testing Plant at St. Louis, Mo., Jan. 1, 1905, to July 31, 1906. Size, 9 by 6 in.; pp., 49. Washington, D. C.: United States Geological Survey.